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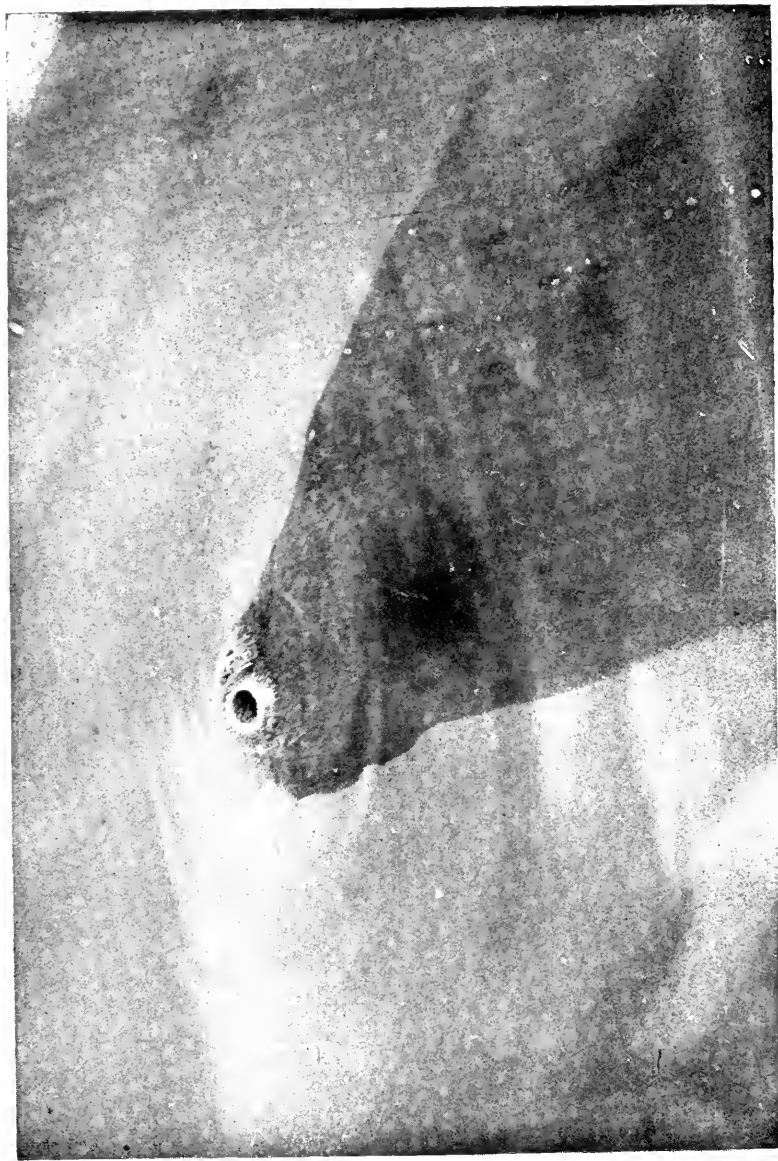
A NATURAL HISTORY OF THE SEAS

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F. W. Bond, photo.

MANATEE (coming to surface to breathe)

[Frontispiece, see page 184]

A NATURAL HISTORY OF THE SEAS

By

E. G. BOULENGER

DIRECTOR, ZOOLOGICAL SOCIETY'S AQUARIUM



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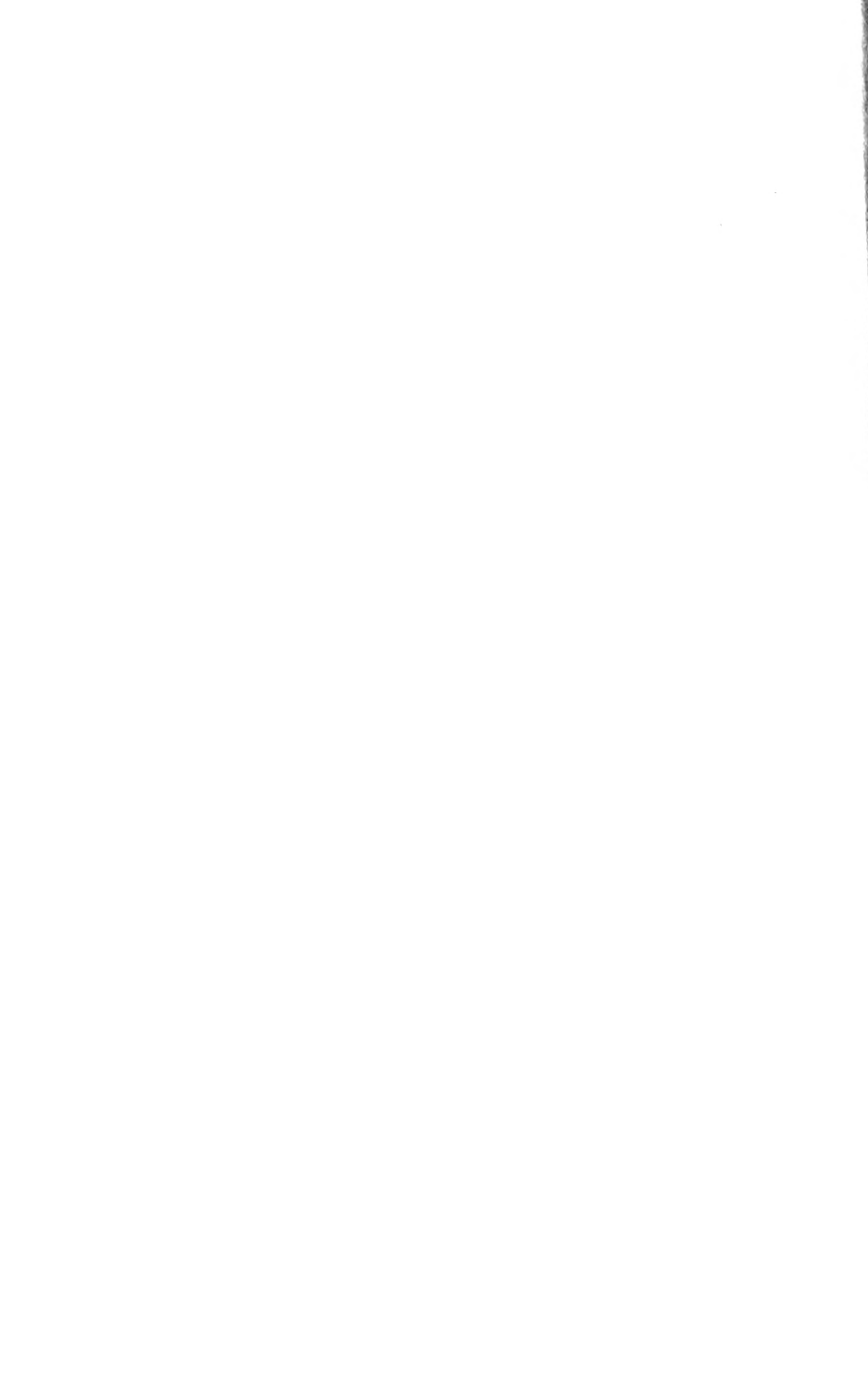
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CONTENTS

CHAPTER		PAGE
	INTRODUCTION - - - - -	9
I.	THE SIMPLEST ANIMALS - - - - -	13
II.	POLYPS - - - - -	19
III.	CRUSTACEANS - - - - -	33
IV.	ECHINODERMS - - - - -	59
V.	WORMS AND POLYZOA - - - - -	73
VI.	MOLLUSCS - - - - -	84
VII.	TUNICATES OR ASCIDIANS AND LANCELETS -	114
VIII.	FISHES - - - - -	120
IX.	REPTILES - - - - -	171
X.	MAMMALS - - - - -	183
XI.	SEA MONSTERS - - - - -	198
	INDEX - - - - -	209

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LIST OF ILLUSTRATIONS

	PAGE
FORAMINIFERA - - - - -	14
PORTUGUESE MAN-OF-WAR (<i>Physalia</i>) - - -	22
GIANT JELLYFISH SHELTERING YOUNG HORSE MACKEREL - - - - -	25
(A) SEA FAN (<i>Gorgonia</i>). (B) POLYPS MAGNIFIED -	27
PLUMOSE ANEMONES - - - - -	31
LARVA OF CRAWFISH - - - - -	34
GOOSE BARNACLES - - - - -	37
FLAT LOBSTERS - - - - -	43
HERMIT CRAB WITH ANEMONE ATTACHED - -	45
SPIDER CRAB (<i>Pisa</i>) DRESSING ITSELF WITH SEAWEED -	49
SECTIONAL DRAWING ILLUSTRATING MASKED CRAB (<i>Corystes</i>) BREATHING THROUGH ANTENNAE WHILST BURIED IN THE SAND - - - -	52
KING CRABS - - - - -	56
SEA GHERKIN (<i>Cucumaria</i>) - - - - -	61
ROSY FEATHER STAR (<i>Antedon</i>) - - - - -	63
STARFISH (<i>Asterias</i>) - - - - -	65
SEA URCHIN (<i>Echinus</i>) CLIMBING ROCK - - -	69
FEATHERY SEA WORM (<i>Sabella</i>) - - - - -	78
WHELK (<i>Buccinum</i>) AND ITS EGGS - - - -	90
SEA HARE (<i>Aplysia</i>) - - - - -	93
CUTTLEFISH (<i>Sepia</i>) - - - - -	109
COMMON OCTOPUS (<i>Polypus</i>) - - - - -	111
TUBE SEA-SQUIRT (<i>Ciona</i>). Above: LARVAL STAGE (enlarged) - - - - -	116
LANCELET (<i>Amphioxus</i>) - - - - -	118
GENERAL TOPOGRAPHY OF SEA BREAM - - -	121
MUD SKIPPERS (<i>Periophthalmus</i>) - - - -	122
FLYING FISH - - - - -	123
DRAGON FISH - - - - -	126
LESSER WEEVER: AND DETAILS OF POISON SPINE ON GILL COVER - - - - -	129
SHARK-SUCKERS OR REMORAS - - - - -	130
STING-RAYS - - - - -	133

	PAGE
GLOBE FISH - - - - -	134
COW FISH - - - - -	135
LAMPREYS - - - - -	137
WHALE SHARK - - - - -	141
SAW FISH - - - - -	143
SWORD FISH - - - - -	145
JOHN DORY - - - - -	148
THE "SWALLOWER" (<i>Chiasmodon</i>) - - - - -	151
DEEP SEA FISHES - - - - -	153
DEVELOPMENT OF FEE - - - - -	158
BUTTER FISH AND EGGS IN OYSTER SHELL - - - - -	166
LUMP-SUCKERS - - - - -	167
COMMON SEA HORSE - - - - -	168
DEEP SEA ANGLER FISH WITH PARASITIC MALES - - - - -	170
GREEN TURTLES - - - - -	175
SEA IGUANA - - - - -	179
SEA SNAKE (<i>Hydrophis</i>) - - - - -	181
DUGONGS - - - - -	185
KILLER WHALE - - - - -	195
RIBBON FISH - - - - -	201

LIST OF PLATES

	FACING PAGE
CRAWFISH (<i>Astacus</i>) - - - - -	42
LANGOUSTE (<i>Palinurus vulgaris</i>) - - - - -	42
SCORPION FISH - - - - -	128
RAY (SHOWING UNDERSIDE OF BODY) - - - - -	132
SPOTTED PUFFER FISH - - - - -	136
JOHN DORY - - - - -	146
DEEP-SEA ANGLER-FISHES - - - - -	152
CALIFORNIAN SEA-LIONS - - - - -	182
MANATEE (COMING TO SURFACE TO BREATHE) - - - - -	184

INTRODUCTION

IN this book an endeavour has been made to survey systematically the ocean's teeming populace in a manner acceptable to the general reader. I have attempted to summarise all the principal groups of maritime life, pointing out the more interesting members and in particular showing how each group contains individuals attuned to almost every conceivable environment provided by the open waters or the coastal areas constituting their boundaries.

How vast is the ocean and how pregnant it is with as yet unexplored possibilities, we are only to-day beginning to fully realise. In the days of early Greece the ocean was regarded as a river flowing round the then known world. Nowadays the ocean is mapped with some accuracy, its waters and the countless waterways which serve to feed it covering more than two-thirds of the earth's surface. The portion immediately washing the great land masses rests upon what is known as the Continental Shelf and is comparatively shallow. This, however, quickly descends to considerable depths and the deeps proper—many of which doubtless yet remain to be discovered—plunge vertically into stygian blackness for from two to more than four miles. The vastness of this body of water reduced to figures is scarcely less intimidating than the statistics inseparable from the study

of astronomy. Even the annual evaporation is so vast that the mind can scarcely grasp it, yet in the immense clock of geologic time such matters seem as moments of an hour, and are not the less impressive when it is borne in mind that they were established features of the natural order millions of years before the human race had come into existence.

Heavily populated as are many portions of the earth's crust—notably the great forest and jungle areas—the terrestrial population is as nothing compared with the waters which are congested with uncountable entities invisible to the naked eye. It was less than 100 years ago that biologists came to the conclusion that both plants and animals ceased to exist in the sea beyond a depth of a few hundred fathoms, but more recent researches have established that even the greatest depths are not without a fauna of their own—a fauna which apparently varies but little in abyssal areas no matter in what portion of the sea they may be situated. Life itself is believed to have had its first inception in the great waters, though the precise nature of such life is at present still conjectural.

Though a tolerable census of the coastal forms of life has been generally appreciated from early times, anything approaching a systematic survey is of comparatively recent date. The British Marine Biological Association—the oldest institution of its kind—dates back as recently as 1884, but since that period almost every civilised nation has followed suit, and by organising research stations, oceanographic expeditions, and a constant interchange and pooling of the knowledge so obtained, a tolerably comprehensive idea of the sea's potentialities is fast being

arrived at. The work has been materially forwarded by the vast strides in mechanism of every kind which the last few decades has seen. Drift bottles and other apparatus serve to track the rate and direction of ocean currents, deep-sea thermometers now give accurate temperature readings, whilst a bewildering diversity of nets allow little that is plant or animal to escape scientific notice. The vast floating populace of microscopic organisms known as plankton is now measured by a device not unlike a large camera film. A gauze ribbon is steadily unwound, whilst being towed behind the survey ship, all creatures adhering to the gauze being automatically preserved as the exposed ribbon winds itself upon a drum. By this means the precise nature and quantity of the plankton over a wide area is accurately ascertained.

The survey ship may use a score of nets attached at intervals to a tow-rope which descends perhaps to a depth of several miles. Yet another device—the “grab”—extracts samples of the sea-floor from any depth required. The contents of fish stomachs are also now largely relied upon to give an idea of the forms of life existing in many situations beyond the reach of either grab or deep-sea trawl net.

Finally the last few years have produced that astonishing device the bathysphere—a huge steel observation chamber which can be let down from a specially equipped ship to a depth of half a mile and from which the scientist armed with a search-light looks out upon the world undreamed of by the early naturalist.

To the layman much of the work that exercises our marine biologists may seem of purely scientific interest

and having little bearing upon practical matters, far less world economy. With each succeeding year, however, the complex interdependence of all animate nature is being more fully appreciated and it may well be that the plankton taken by some scientist to-day may bear indirectly but not the less forcibly upon human welfare several decades hence. It is generally recognized, for example, that all marine life is ultimately dependent for its being on the myriad microscopic plants that throng the waves in the spring and early autumn. They constitute the first link in what is nowadays generally termed the "food chain." As an example it may be pointed out that such plants form the basis of food which nourishes the minute creatures that go to feed the first stages of the herring and many other food fishes. The larger herring itself eats its smaller brethren, whilst sea birds, large fish, seals, whale and man depend largely upon the herring for their sustenance. It will be appreciated, therefore, that plankton and all the factors which control its rise and fall are matters of primary importance and much more than a mere academic study for the laboratory worker.

In the following pages the marine fauna of the world will be dealt with in scientific order, though only those creatures of more striking interest or more obvious importance to human welfare can be touched upon in any detail.

CHAPTER I

THE SIMPLEST ANIMALS

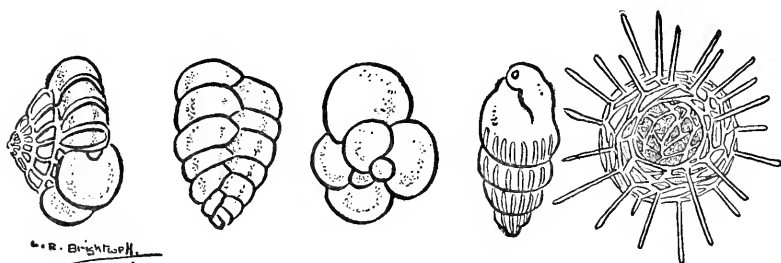
THE Protozoa, or simplest animals, constitute the most vital portion of the sea's population. They consist essentially of a single-cell and are not built up of millions of cells as are the vast majority of other animals. Most of these minute creatures are in varying degree mobile. Some are highly so and row themselves hither and thither at a great pace by means of minute hairlike organs or "whips." Some are naked, others are endowed with shells, and a few are of such indeterminate structure feeding in the manner of plants that there is still much doubt as to whether they fall in the animal or vegetable kingdom.

The shelled species (*Foraminifera* and *Radiolaria*) show a bewildering diversity in the structure of their minute homes—often of exquisite design, and were until 1835 regarded as minute molluscs akin to the whelk and oyster.

It was Du Jardine who in that year startled the scientific world by establishing that the animals within were of the simplest construction—mere blobs of protoplasm which crept along by extending hairlike filaments through minute orifices in the shell's walls. Large areas of the ocean bed are covered many yards deep with their deposits and the dead shells of these animals may eventually become

by compression solid ground. When raised above sea level, they form the well-known limestone cliffs.

Whilst the vast majority of Protozoa must be thought of as creatures of from one-hundredth to three-hundredth of an inch in diameter, a few are just visible to the naked eye. Large examples are the beautiful marine Noctiluca—"night-light" creatures which when they congregate in millions light up wide areas of the sea with a vivid phosphorescent glow.



Foraminifera

A sponge is fairly typified in the minds of most persons by the common bath sponge which is so extensively farmed in warm seas for toilet purposes. The form that is sold in shops is but the horny skeleton of a large colony, each individual being bound one to the other to form a single solid mass. All are interdependent for the general welfare on the other members of the community.

To appreciate the true nature of a sponge one should obtain a portion of one of the many species common round our shores, or failing this, a branch of the vivid green fresh-water sponge so common upon lock gates and canal buttresses. A fresh specimen placed in water to which

has been added a little carmine soon reveals the fact that it is not, as at first appears, a vegetable growth, incapable of independent action, since the coloured water can be seen to be flowing in a rhythmic pulsating manner. The holes or pores of the sponge lead to a complex series of canals off which branch small chambers lined with hairlike whips which ceaselessly lash the water, and by so doing set up currents that carry food to the sponge's interior. The non-assimilated matter is ejected by outflowing currents which escape by special openings. The body substance as seen in the bath sponge is composed of minute pieces of a material chemically allied to silk, and these in life are bound together by a slimey pulpy tegument often of vivid coloration. Sponges are reproduced by means of egg-cells. The larvæ hatched from these lead free-swimming lives for a few days, later settling down and forming the basis of a sponge colony which by cellular division may eventually increase to giant proportion.

Sponges are classified according to the presence or absence of a skeleton and its nature. The pretty little Flask Sponges (*Sycon*), which build their skeletons of carbonate of lime, are abundant amongst tufts of seaweed. They vary from a half to seven inches in length, and if placed in water will demonstrate the circulatory system common to the entire order.

The graceful Fig Sponge (*Ficulina*) seems to be especially associated with a hermit crab. Other sponges of this order become attached to the shells of crabs or encrust the mollusc homes affected by hermit crabs, on which they may grow to a large size. When this occurs the sponge may almost completely cover the shell, leaving the

crustacean with merely a small opening to obtain its food.

The Glass Sponges, which belong to the group of siliceous sponges, come from deep water, usually in tropic seas, and include some of the most beautiful species known. The skeletons are built up of large six-rayed spicules, which combine to form intricate and exquisite designs. The Glass-rope Sponges from Japan are remarkable for a species of root-tufts of immensely long spicules which form a tassel of what appears to be finely spun and very flexible glass threads, the whole somewhat suggestive of a flat-tailed fly whisk. The Glass-rope, as it is aptly called, serves in life as an anchor holding the upper portion or sponge proper securely to a muddy sea floor. The first specimens acquired in this country were supplied by Japanese dealers, who by way of adding to the specimens' interest fixed the glass rope into pieces of coral—a piece of trade deception which mystified scientists until living specimens were finally obtained by the dredge.

Some smaller but similar sponges are found off Portugal, and both there and in Japan are commonly brought to the surface attached to the hooks of fishermen.

The common or fleshy sponges are abundant in all seas and comprise a great variety of forms. The Boring Sponge (*Cliona*) is too abundant to please those responsible for oyster farms or the maintenance of sea walls. It tunnels both oyster shell and hard lime-stone boulder until the solid matter is reduced to so much honeycomb and disintegrates from erosion. A peculiar boring sponge excavates long galleries in the oyster's shell, covering the outside of the shell with a slimy film of white or creamy

tint. At some oyster stations it is common to grow the oysters on wire frames which can be raised at intervals and exposed to a shower of rain. The fresh water kills the sponge, but the oyster by closely shutting its shell remains unscathed. To this group belong the vivid green fresh-water sponges.

The Bathsponges with their skeletons of horny yellowish substance, and the highly-organised industry to which they have given rise, deserve special mention. Three main species are fished in the Mediterranean; the most important fisheries have long been established in Florida, the Aegean Sea and North Africa. These sponges, so attractive in their commercial form, are black and slimy during life and are securely anchored to shells, rocks or other solid objects. Up-to-date diving apparatus is often used to gather them, but much of the work is still done by naked native divers, whose methods of operation vary with the locality. The native divers of the Aegean are world-famous for their skill and endurance. The diver has a life-line attached to his right arm and thus equipped leaps overside with a 30 lb. block of marble, which bears him to the sea-bed 12 to 40 fathoms below. Here he stays for about two minutes, filling a basket with sponges at lightning speed, when he is hauled to the surface, his marble "sinker" attached to another line being recovered separately. The sponges are stamped upon and beaten and then hung overside for twenty-four hours in order to remove the last of the slimy substance. There follows more beating, many washings, and finally a period of drying in the hot sun, the sponges being hung on lines. In some areas bathsponges are propagated by

cutting. A small portion is cut off, care being taken that some of the outer skin is retained or the operation comes to nothing, and under favourable conditions a cubic inch of sponge will reach marketable size in about seven years.

Unknown to the bather myriads of embryo sponges may surround him in the sea-water and many species which from time to time appear in the Zoo Aquarium brought in with fresh consignments of Atlantic sea-water are unsuspected until they attain to discernible proportions.

CHAPTER II

POLYPS

UNDER the convenient name of Polyps (*Coelenterata*) are massed together a vast number of creatures which though sufficiently diverse of form have many features in common. The group in question includes such apparently dissimilar animals as the Sea Anemones, reef-building Corals, and Jellyfishes.

A typical Polyp is an individual creature of simple design, having a cylindrical hollow body, one end of which is fixed by an adhesive disc to some stable object. The other end is ringed with arms or tentacles, which gather food from the water and thrust it into the body cavity into which the mouth opens direct. A typical Polyp expands when desiring food and when at rest, as during the processes of digestion, contracts sometimes to a more or less shapeless mass of jelly. Though apparently soft and defenceless it is usually well armed with stinging cells—to be described later—and being of an elastic nature can often overpower and engulf a victim larger than itself.

The group is broadly divided into : (1) Hydroids—Sea-firs and small Jellyfishes ; (2) Siphonophores—Portuguese Man-of-war, etc. ; (3) the Scyphozoa—the true Jellyfish ; (4) Ctenophores—or Sea Gooseberries, etc. ; (5) Corals and Sea Anemones.

To the casual observer many of the Hydroids will not be recognisable as animals at all since the bulk suggest tangled tufts of weed. The lens, however, will reveal them all as branching tubular growths. The animals—flowerlike in form, are built much on the plan of a Sea Anemone, and, like the Sea Anemone, feed on living organisms which they capture with their petals or tentacles. Each separate animal is known as a Polyp and each is connected to its fellow by living tissues. These colonies of Polyps increase by the mode of reproduction known as “an alternation of generations, by budding off, or by laying eggs.” In the first method certain of the Polyps give rise to a colony of buds which presently develop into a series of minute jellyfish piled like saucers one upon another. These in due season break away and swimming off on their own account lay eggs which eventually give rise to other branching colonies of fixed Polyps. Thus a fixed generation gives rise to a swimming one, and the swimming one to a fixed one.

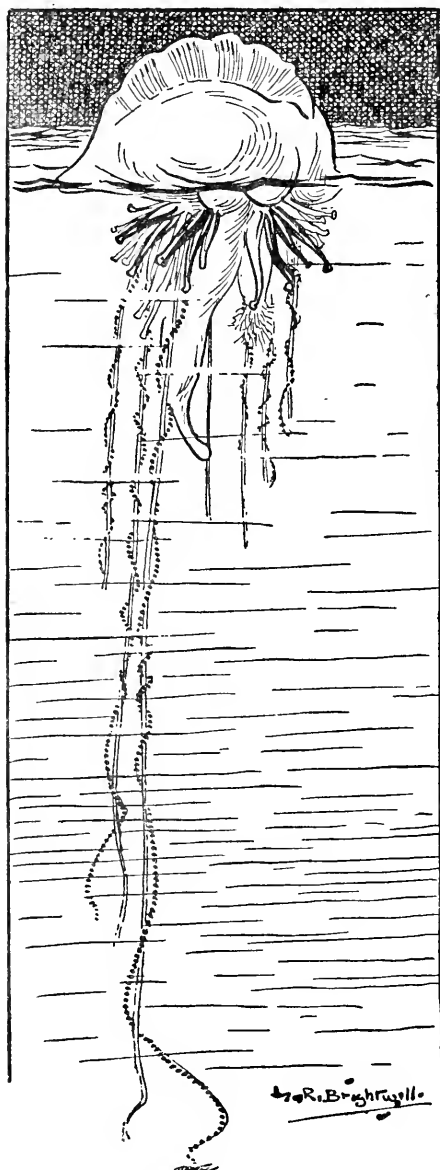
A large number of these quaintly-formed, exquisitely-coloured Hydroids are found throughout the summer in home waters. A common species is sometimes found on whelk shells tenanted by the common hermit crab and owing to the spiny nature of the colony’s horny skeleton is known as the Hedgehog Hydroid (*Hydractinia*). In this form the expanding Polyps are about half an inch long and may be observed twisting from side to side and snatching at scraps of food in the liveliest manner.

In some tropic seas Hydroids reach a huge size. In the British Museum may be seen a Japanese species dredged from deep water which consists of a single solitary Polyp

anchored in the mud. The single Polyp may be 4 ft. long with a 2-ft. spread of tentacles and is the subject of a weird legend current among the native fishermen, namely that it guards the bower of a beautiful sea-maiden.

Next in order to the Hydroids are the *Siphonophores*. Though commonly called Jellyfish, these are more complex creatures than the true Jellyfishes found stranded on our shore or the minute Jellyfishes of the Hydroids just described. The Siphonophores appear to be individuals, but are in fact colonies of many individuals. Some are concerned only with the capture and digestion of food; others concentrate upon reproduction; whilst others again have formidable batteries of stinging cells which kill or sting the prey and keep foes at a distance. Most of these creatures carry a floating bladder filled with gas which acts as a support in the water.

The commonest of our home species is a small transparent bell-shaped form having no other name than *Muggiæa atlantica*. More startling are the forms popularly known as the Saltee-rover and the Portuguese Man-of-war semi-tropical forms which occasionally appear off Devon and Cornwall in vast numbers. Each colony is supported by a gas-filled bladder an inch or two across and of a vivid indigo blue. Fleets of these creatures may form long lines or platforms visible far out at sea and drift helplessly before the wind. As they reach colder waters they soon die and disintegrate, detached floats or bladders sometimes surviving as far eastwards as the Sussex coast. The float of a Portuguese Man-of-war carries a crest which projects above the surface of the water and acts as a sail. It may reach a foot in length, and is a most con-



Portuguese Man-of-War
(*Physalia*)

spicuous object, being of a vivid azure blue topped with pink. Long bright blue tassels of stinging cells depend from the disc for several yards beneath the float and upon coming into contact with a living object at once contract and draw the prey, paralysed and unresisting, up to the many "mouths."

As with a large number of other members of this and allied orders, the Man-of-war provides for a number of "gate-crashers." Chief of these are certain small fishes which live amongst the deadly stinging cells apparently enjoying their protection. The stinging powers of the Man-of-War are more severe than those of any other known Jellyfish, and in tropic seas native pearl and sponge divers dread them even more than they do the shark.

It may be not inappropriate here to offer a word of explanation regarding the stinging properties common to all creatures under consideration in this chapter. The small Sea Anemone or Jellyfish may cause no more than a tingling sensation to the human hand, but the same creatures can spell death to small animals. This paralysing influence is exerted by myriads of minute mechanisms, each one a miniature replica of the old-time harpoon with its attached rope. When highly magnified, a stinging cell is seen to consist of a double-barbed dart attached to a neatly-coiled thread, the whole enclosed in a compact ovoid capsule. At the small end of the capsule is a spring trigger arrangement and this being touched by some foreign body automatically releases barb and thread with considerable force.

The *Scyphozoa* or true Jellyfishes when adult swim freely in the open sea. The common Moon Jelly (*Aurelia*),

often distressingly abundant in warm weather off our coasts, may be taken as a typical example. In its early stages it becomes attached to a rock at low tide and may then be mistaken for a very small Sea Anemone. As it increases in size, however, an extraordinary transformation takes place. The creature develops a long series of constrictions throughout its length and it is later apparent that the animal is not one but many individuals all circular in shape with tentacles arranged round the circumference, the whole piled one upon the other like a stack of dinner plates. When fully developed these detach themselves one after the other, each embarking on a career of its own and progressing by means of those umbrella-like expansions and contractions which every seaside visitor has observed.

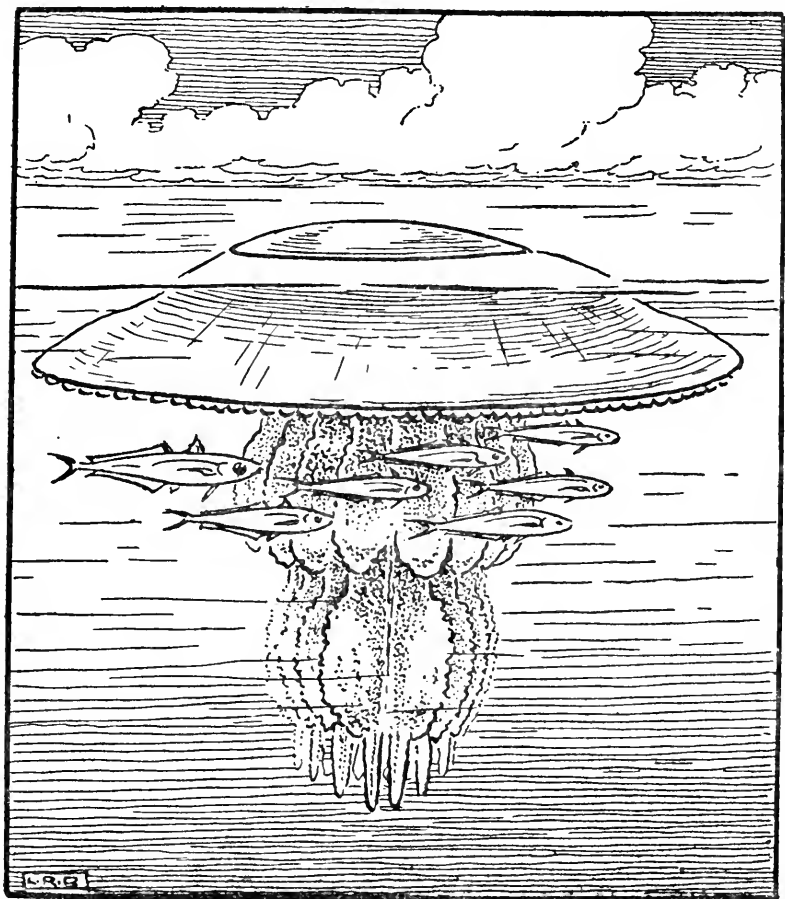
The commonest stinging form which is justly dreaded by bathers is *Chrysaora*.

The largest species found in our seas is *Rhizostoma*, which may have a diameter of 2 ft. The fry of the horse mackerel habitually shelter beneath its large flattened umbrella, which protects them from the searching eyes of sea birds, whilst the abundant stinging cells ward off predacious species of their own order.

The giant of the race is *Cyanea*—the Sea Blubber, which reaches its maximum diameter of 8 ft. with tentacles 120 ft. long in the waters north of Cape Cod. It is likewise a noxious jellyfish. Such a monster is, like the rest of its clan, composed largely of sea-water, the actual organic tissue in its composition comprising not more than five per cent. of the entire bulk.

The *Ctenophores*, or Sea-gooseberries, carry swimming plates—combes of partly fused hair-like organs—that by

continually lashing the water propel the creatures onwards. A familiar form in home waters is the little Sea Gooseberry.



Giant Jellyfish sheltering young Horse Mackerel

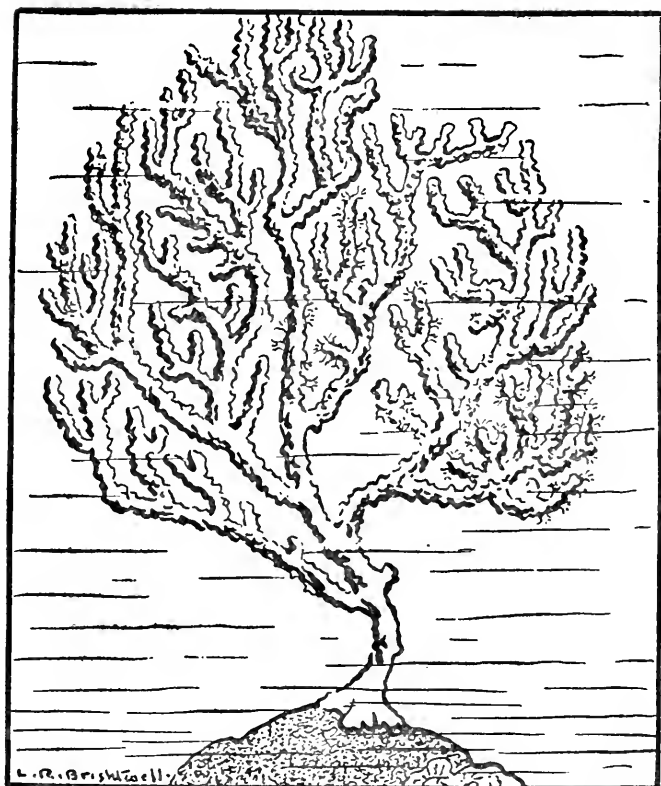
From its globular form depend two long threads. These threads can be drawn up into pockets and when extended

may attach themselves to small animals. Though no larger than the fruit from which it takes its popular name, the Sea Gooseberry does considerable damage to shoals of fish fry, besides killing large numbers of larval crabs and lobsters.

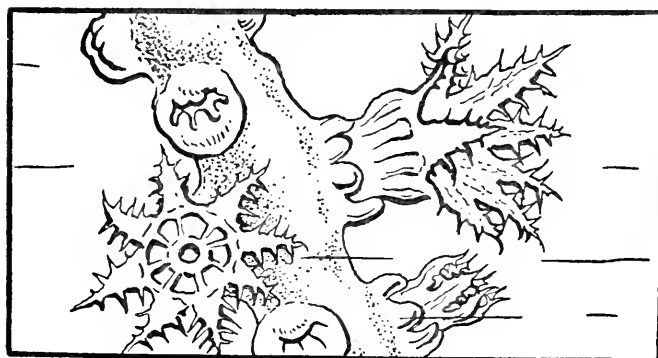
Certain Ctenophores inhabiting foreign waters are of a weird and beautiful design. To these belongs the ribbon-shaped Venus's Girdle (*Cestus*), which grows to several feet in length. In this animal the constant movement of the prismatic swimming plates causes an unbroken succession of dazzling colours to play over its entire length.

Coral is a term given to a group of polyps which manufacture a skeleton of lime. Some are solitary, but the majority form colonies in which the various individuals are connected by a system of tubes so that the food of one is shared by all, whilst the entire assemblage is embedded in and supported by spicules of carbonate of lime. The skeletons may form solid stony masses as in the Precious and Reef-building Corals. When the spicules are scarce and scattered the result is a "Flexible Coral," of which home waters supply several beautiful examples.

The commonest perhaps is the form known by the gruesome name of Dead Men's Fingers (*Alcyonium*), often seen in its contracted form attached to oyster and scallop shells. In water the little Polyps slowly expand suffusing the dead creamy coloured finger-shaped mass with a rosy pink flush. More striking still is the lovely Sea Fan (*Gorgonia*), whose spreading pinkish-orange fronds are dredged just beyond low-water mark. This coral has a tough horny internal skeleton, which when found washed



a.



b.

(a) Sea Fan (*Gorgonia*). (b) Polyps magnified

ashore and denuded of its limey Polyp shells is often mistaken for a shrub torn from the cliff or foreshore.

Polyps which invest themselves with stony tenements abound in most tropic seas but are by no means confined to them. Several species come from deep water in northern latitudes and one is tolerably common off our south-western shores. The latter is known as the Devonshire Cup Coral (*Caryophyllia*). Its white stony house stands about half an inch high and the brilliant flower-like Polyp when expanded towers above it, retreating with lightning speed, however, at the slightest disturbance.

Since the publication of Darwin's famous work much literature has been devoted to the study of corals and coral reefs, whilst the coral itself has been devoted to innumerable uses from the earliest times. The famous Precious Coral comes chiefly from the Mediterranean and from earliest antiquity has been prized as an ornament, and an antidote to poisons, as well as a general panacea. This coral reproduces by eggs or buds, the male and female polyps being segregated in separate colonies. The gathering of the Precious Coral is effected by a crude drag made of thick nets attached to two heavy beams joined in the form of a cross. The coral being brought ashore is stripped of its outer bark and subjected to an elaborate process of polishing.

Reef-building Coral forms the stable building material in all the countries where it occurs. Reef Corals are the result of the union of Polyps, each divided Polyp raising around itself a wall of hard limey material. Since the colonies grow from the bottom upwards, the pressure exerted by later generations consolidates the vacated homes

of defunct members into one massive block, which offers considerable resistance to wind and waves. It likewise serves as a haven for the enormous numbers of molluscs, worms, sponges, etc., that habitually tunnel into it for shelter. Reef Corals can only form in comparatively shallow water, light and air being essential to their makers' well-being. Two such reefs are world-famous—the Great Barrier Reef of Australia, extending for 1,315 miles from New Guinea southwards along the entire coast of Queensland, and the notorious Cocos Atoll, never for long out of the news as a home of treasure trove.

Coral reefs are divided into three well-defined groups. (1) Fringing reefs, which occur round continents or islands ; (2) Barrier reefs, that form much farther out from land masses, with a deeper channel between them and the land than is permitted by the former type ; and (3) Atolls, which are roughly circular in formation, often situated far from land, with much of their boundaries raised above sea level. Within the atoll reef is a still lagoon never exceeding 50 fathoms in depth. The shelter afforded transpires to make these reefs the retreat of innumerable sea animals of every kind and constitute a wealth of life that would appear to be literally unlimited despite its wholesale exploitation and despoliation at the hands of man.

Sea Anemones are practically world-wide in distribution, and their variety of size and coloration is so great that it can here be only touched upon. Most Anemones remain fixed to some stable object throughout life, though many can slowly glide from one spot to another by means of the flattened lower portions of the body. The crown

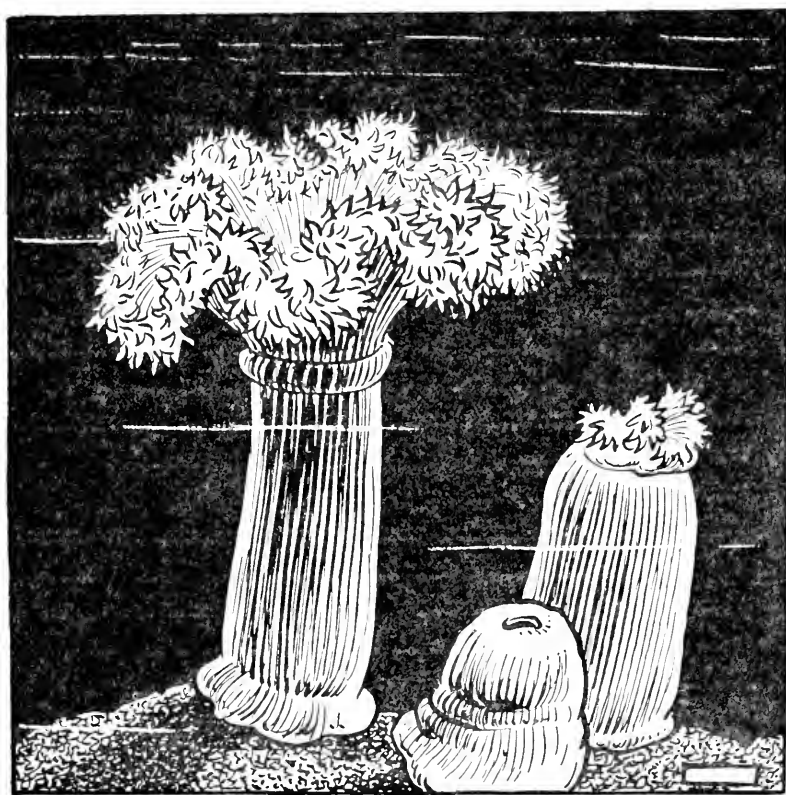
of retractile tentacles varies in number from a few score to many thousands according to species and they are constantly employed to seize and convey food to the stomach cavity which constitutes the bulk of the cylindrical body. Multiplication is effected by means of eggs, budding off, or even as the result of mutilation. Some species if cut in fragments give rise to as many new individuals.

A large number of species are found in our own waters, and their ways of life are infinite. The majority anchor themselves to rocks, whilst a few, like the Dahlia Anemone (*Telia crassicornis*) and the Sand Anemones, attach themselves to shell fragments buried some distance in sand or gravel, the crown of tentacles showing just at the surface when the animal is searching for prey. The Opelet Anemone (*Anemonia sulcata*), one of our commonest native species, often chooses such unstable anchorage as the fronds of seaweeds.

Anemones are of little direct economic value to man, though the Dahlia is sometimes eaten on the Continent, and on our own northern coasts is in demand as bait for long lines.

A highly interesting feature of the group is the extent to which many species are found in peaceable association with widely different creatures. Our own shores provide two notable examples. The common Parasitic Anemone (*Sagartia parasitica*) is a large species invariably found attached to shells tenanted by the common hermit crab. There is little doubt that the crab derives direct benefit from its cumbersome messmates—for three or more anemones sometimes attach themselves to a single shell.

Not only are the anemone tentacles a deterrent to hostile fishes, but the polyp when irritated throws out from its columns immense numbers of long white threads which



Plumose Anemones

not only entangle the aggressor but have marked stinging properties. The benefits afforded to the anemone are very obvious, for when the crab is feeding the polyp

bends over towards the centre of operation and take its full share of the feast.

Recent observations have shown that sometimes the crab's lodgers become so large and numerous as to constitute an embarrassment and force him to seek another home. The Velvet Cloak Anemone (*Adamsia palliata*) is likewise parasitic, living on a small hermit crab. The polyp in time dissolves the shell and the crab is thus comfortably ensconced in an elastic tenement permitting his ample expansion and no longer necessitating as he grows in size that constant search for more spacious accommodation which occupies so much of the average hermit crab's career.

The Velvet Cloak Anemone is found only in association with the smooth-clawed hermit crab, and invariably tucks itself just underneath the shell so that its eager tentacles are always within easy reach of the crab's mouth and any food the latter may be negotiating.

Still more remarkable is the partnership between a small Indo-Pacific crab and certain anemones. The crab detaches the anemones from the rocks and carries them in its claw, employing them as knuckle-dusters to ward off foes.

A giant anemone of the Barrier Reef may reach 2 ft. in diameter, and is the chosen host of certain brilliant little Coral Fishes of a kind often exhibited in the Zoo Aquarium. These fishes and also a species of prawn closely approximate to the anemone's colouring and habitually shelter in the polyp's gastric cavity, always hurrying to this strange shelter on the slightest hint of danger.

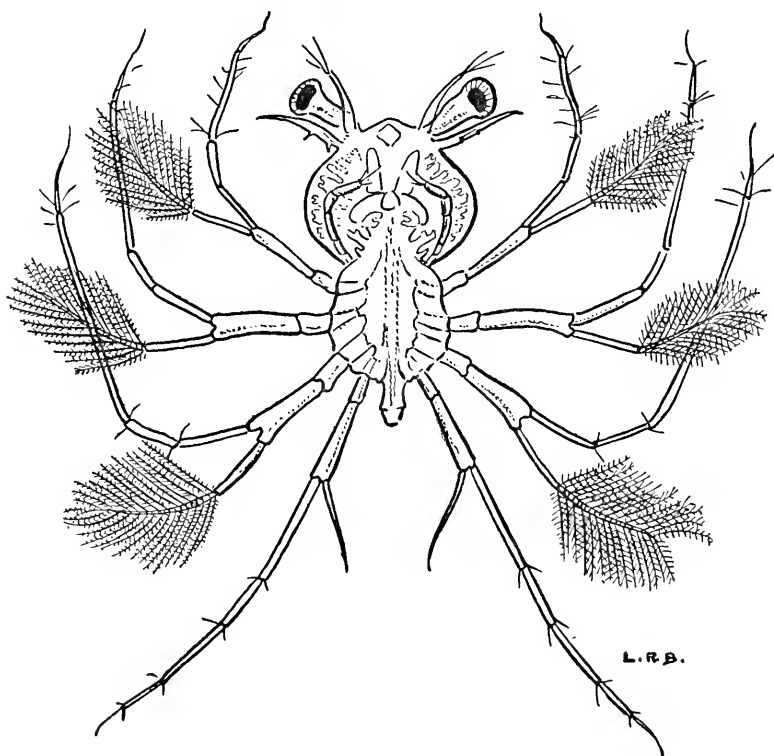
CHAPTER III

CRUSTACEANS

NO branch of the animal kingdom is more abundantly represented on land or in the waters—fresh, brackish and salt, than is that of the jointed animals or Arthropoda. The group includes the Crustaceans, Trilobites, Spiders, Centipedes and Insects, all of which have representatives within the maritime zone, the Crustaceans being, however, predominant in that region.

The Crustaceans are known to the general public by such common forms as the Wood Louse, Sandhoppers, Barnacles, Shrimps, Crabs and Lobsters, animals sufficiently diverse in appearance and economy yet all presenting certain points in common. The bodies of all these creatures are divided into segments, each segment bearing a pair of appendages. These organs are modified in a variety of ways, some serving as tactile organs, others being employed for seeing, chewing food, or various means of progression. The animals are encased in more or less unyielding suits of armour which must be periodically cast off to permit of expansion, a new shell being formed beneath the old one. Reproduction is almost invariably effected by means of eggs, the young sometimes resembling the parents, but in many cases passing through a series of complex transformations before reaching the adult form.

The COPEPODS, though small, are of enormous importance in the balance of life, for they form the staple of the plankton and not only do much useful work as scavengers, but feed much larger creatures, some forming the bulk



Larva of Crawfish

of the “ whale food ” consumed by the cetaceans. A vast number of these minute but restlessly swimming creatures abound in the sea throughout the summer months, whilst our inland ponds and ditches supply such a common form as the Cyclops.

In the sea the Copepods both as regards species and individuals are indeed legion. One abundant form, *Calanus*, deserves to be as well known as the crab or lobster since it is infinitely more abundant, and without it the herring harvest would fail to reach maturity. This minute crustacean may so abound at times as to cover some square miles of the sea surface with a reddish scum and a single tow of a few minutes' duration has choked a muslin net with two and a half million specimens—sufficient to fill ten pint tumblers solid.

Some Copepods are of exquisite form and colour, whilst many display many fantastic spines and fancy appendages, which serve to maintain their balance.

The group known as CIRRIPIEDIA includes a large number of strangely divergent forms spoken of collectively as Barnacles. The majority commence life as active free-swimming creatures, but after casting their shells several times they attach themselves by the head to some solid object—rock, stone, crag, or ship's keel, and there undergo a startling transformation. The shell or carapace which encloses the larval body changes into a tower-like structure made of several neatly welded plates, the upper or open end being closed by two pairs of folding doors, which can be pushed aside to admit the free passage of the legs. The latter organs no longer of service in rowing the animal through the water serve merely, as Professor Thomas Huxley aptly put it—to kick the food into the stomach.

By far the best known example is the little Acorn Barnacle (*Balanus balanoides*), which covers every rock and harbour pile, its sharp-edged shells being justly disliked

by the bather. On a very still day one may hear a gently hissing sound which is caused by countless millions of these creatures oscillating the jointed lids of their residences in impatient anticipation of the returning tide. In the far north these barnacles reach a large size, one species having a shell fully four inches in height.

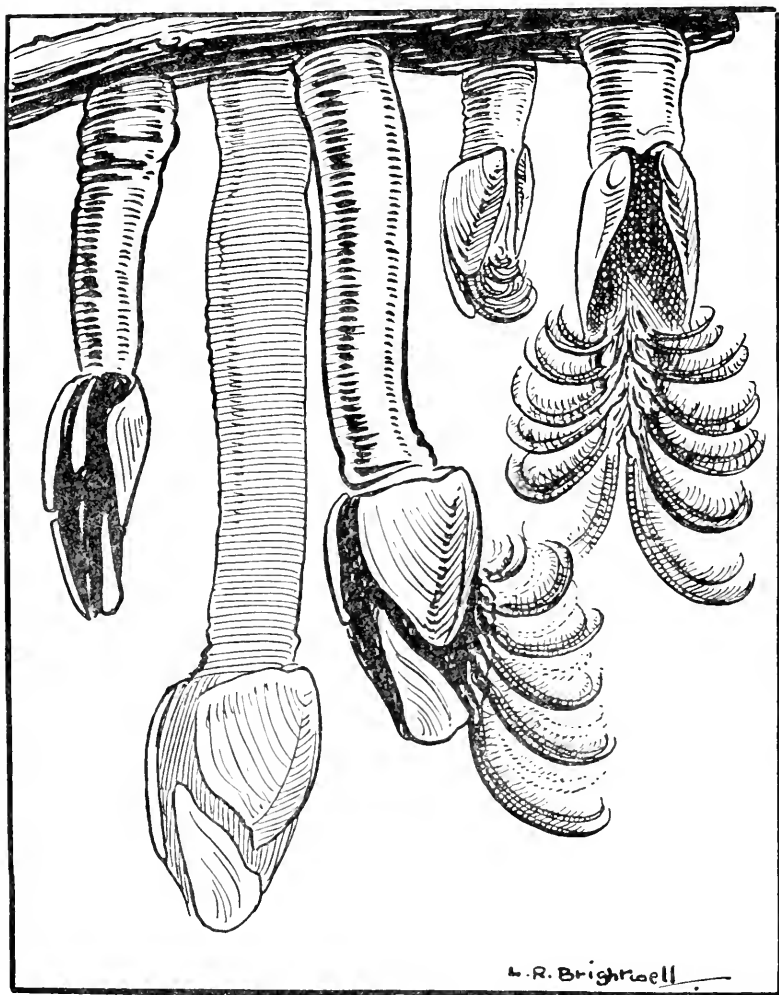
Another abundant form is the Goose Barnacle (*Lepas anatifera*), which may be recognised by its flattened shell and the long tough sinuous stem which anchors it to floating timber and which represents the last remnants of the creature's head. In mediæval times this crustacean was in some way confused with the barnacle goose, the bird having been seen in the vicinity of the tree branches which at low tide revealed themselves as being covered with barnacles. It thus happens that many quaint old woodcuts testify to the once general belief that the barnacles grew on trees and actually developed into birds. Some assert that the belief, which dates from the twelfth century, had its origin in a priestly desire to give the goose a vegetable origin and so extend the Lenten bill of fare.

On our southern coasts and much more abundantly in the Mediterranean there abounds a form, allied to the common Goose Barnacle, but having less solidly formed shells, which is sold for food.

One species of sessile barnacle, *Tubicinella*, actually burrows into the skin of whales.

A very remarkable group of barnacles has carried degeneration yet a stage farther. The seaside visitor may often find a crab with a tough fleshy knob firmly attached to its abdomen. This is the Sack Barnacle, *Sacculina*. It hatches from an egg into a free-swimming larva almost

identical with that of the Acorn Barnacle, but it later



Goose Barnacles

loses every vestige of shell and becomes a mere stomach

attached to a crab, deriving nourishment by sending an endlessly ramifying series of roots into every portion of the more active crustacean's interior. A crab so visited is usually doomed, but before succumbing to its repulsive parasite undergoes various modifications, the male crabs taking on certain female characteristics.

The ISOPODS—claw-footed crustaceans—are typified in the common Wood Louse, and in the maritime zone present a galaxy of varied forms. They have no carapace and the eyes are set flat and not raised on stalks.

The Gribble *Limmoria*, though of minute proportions, does immense damage to all wooden structures exposed to salt water, eating away the wood until it is of the consistency of a sponge. Many ships, piers, and harbour structures have thus been completely undermined much as terrestrial woodwork often succumbs to the death-watch beetle.

The Isopods also include the common Sea-Slater (*Ligia*)—a useful scavenger—and many large and handsome fish parasites, including the strange degenerate creature *Bopyrus*. In the latter crustacean the female takes up residence in the gill chamber of the common prawn, causing a blister-like protrusion of the carapace and earning for its host the fishermen's somewhat ribald appellation of "Face-ache" Prawn.

The AMPHIPODS are well known to all by the Common Fresh-water Shrimp and the still more abundant Sandhopper or "Beach Flea." The latter literally swarms on most shores, and unlike the Fresh-water Shrimp always keeps

just above water-mark, where it devours refuse of every description, 20,000 having been counted on a single small sea-urchin. Many carry the eggs beneath them in the manner of crabs and lobsters, and a number of species construct nests. A few take up their residence within jellyfish, apparently being immune to the Coelenterate's stinging cells.

Most striking of all the Amphipods perhaps are the grotesque "Skeleton" Shrimps, which abound amongst corallines clambering about the tangled growths in the manner of looper caterpillars. To the Amphipods also belong the large Whale Lice that attach themselves to cetaceans by means of their strongly-hooked legs.

The STOMATOPODA or Mouth-footed Crustaceans are represented by the remarkable Mantis Shrimps (*Squilla*) found on our southern shores and attaining a large size in all tropical seas. They are long flattened creatures with a pair of huge scythe-like forelimbs which in general structure and the sharp spines fringing their inner surface recall the well-known Praying Mantis, one of the tigers of the insect world. These crustaceans lay several thousands of eggs which are rolled into a ball and carried in the mouth of the female for a period of two or three months. Mantis Shrimps though abundant are seldom seen since they dig deep burrows just beyond low-water mark, leaving these retreats only after dark. Being of excellent flavour they are much prized for food, and in many lands, especially in Italy, where they are known under the name of "Scampi," it is customary to lure them into traps by means of lantern lights.

The DECAPOD Crustaceans, as the name implies, have ten walking limbs, two of which are usually developed into large and well-formed pincers characteristic of the Crabs, Lobsters and their allies. The group's distribution is world-wide, its representatives abounding both in the shallows and the abyss, and are not only of great commercial value but have played an important part in the beliefs and folk-lore of various nations. The Ancient Greeks and Romans promoted the crab to be an important constellation—Cancer being the fourth Zodiac or sign of the heavens. Olaus Magnus, Archbishop of Upsala, and a great disseminator of “unnatural history” in the sixteenth century, placed on record that the seas around the Hebrides harboured a lobster capable of capturing a man and similar stories may be found amongst the legends and beliefs of many primitive people to this day.

The group is divided into the Long-tailed, Short-tailed, and Anomura, which by some is regarded as an aberrant offshoot of the first-named. The long-tailed crustaceans are exemplified by the graceful prawns abundant on all rocky shores and represented both in coastal waters and the uttermost depths. Deep water species are usually of a vivid red tint and are often poised on abnormally long legs, a provision for walking upon shifting and unstable ooze, much as some Fenland shepherds tend their flocks on stilts.

A large number of species of shrimps and prawn are found around our coast, the prawns usually being caught in baited pots whilst the shrimps are dredged. A common edible prawn (*Pandulus montagui*) is taken in the trawl, and being of delicate structure is cooked on board.

Examination will reveal that its pincers are minute and placed at the end of long whiplike limbs, a modification believed to be brought about by constantly probing the long and tortuous tubes of certain sandworms which appear to be its principal food.

Of late years several very large prawns from both sub-Arctic and Mediterranean waters have become a regular feature of our markets. Prawns, like all the long-tailed crustaceans, are of very active habit and by suddenly "snapping" the tail fin can project themselves through the water backwards at high velocity and with considerable precision. The prawns like all the members of the three groups carry their eggs attached to the "swimmerets" of their undersurface, the emergent young passing, as a rule, through a series of transformations before attaining maturity. Often these larvæ bear grotesque horns and other balancing appendages and it is of interest to note—as indicating a common ancestry—that widely dissimilar adult forms of different species often show a remarkable uniformity in their larval stages.

Several species of prawn bear light organs, whilst one abysmal species covers retreat in a smoke-screen of highly phosphorescent fluid, which it ejects from a special sac much as the cuttlefish of shallow water discharges its ink cloud.

The lobsters include the largest members of the group. Our Common Lobster (*Homarus vulgaris*) and its common American relative (*Homarus americanus*) have a northern range, the New World species being of stouter build, its great crushing claw alone sometimes weighing 10 lbs.

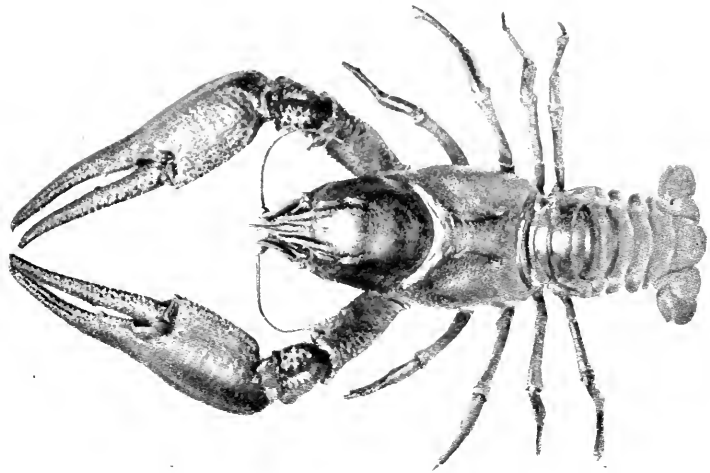
The crushing claw may be either right- or left-handed, specimens occasionally having both claws of the crushing or cutting type. Lobsters show great variety of colour, deep water specimens tending to be of a darker blue than the shallow-water forms, whilst such colour freaks as pale blue, mauve, red and even albino lobsters are not unknown. These crustaceans are omnivorous and are highly pugnacious. The entire group has the power to reproduce lost limbs, a useful provision since injuries necessitating the discarding of the limb at a special joint are of frequent occurrence.

The smaller and more elongate Norway Lobster or Dublin Bay Prawn (*Nephrops norvegicus*) occurs in deep water off our western coasts.

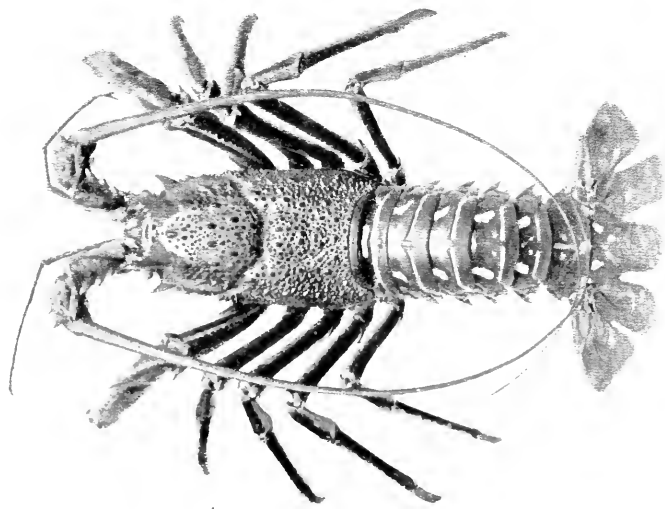
Allied to the lobsters are the handsome Crawfish and Flat Lobsters, which lack the large pincer claw of the true lobsters. The Common Crawfish, or Langouste of the French (*Palinurus vulgaris*), is the largest of all the long-tailed crustaceans, the body and tail often measuring 2 ft. in length, whilst the long and inflexible antennæ considerably exceed this measurement. By rubbing the bases of its antennæ against the central beak or rostrum it can produce a loud grunting noise.

In the related Flat Lobster (*Arctus ursus*) the antennæ form large broad flattened plates, which serve to shovel up silt and conceal food.

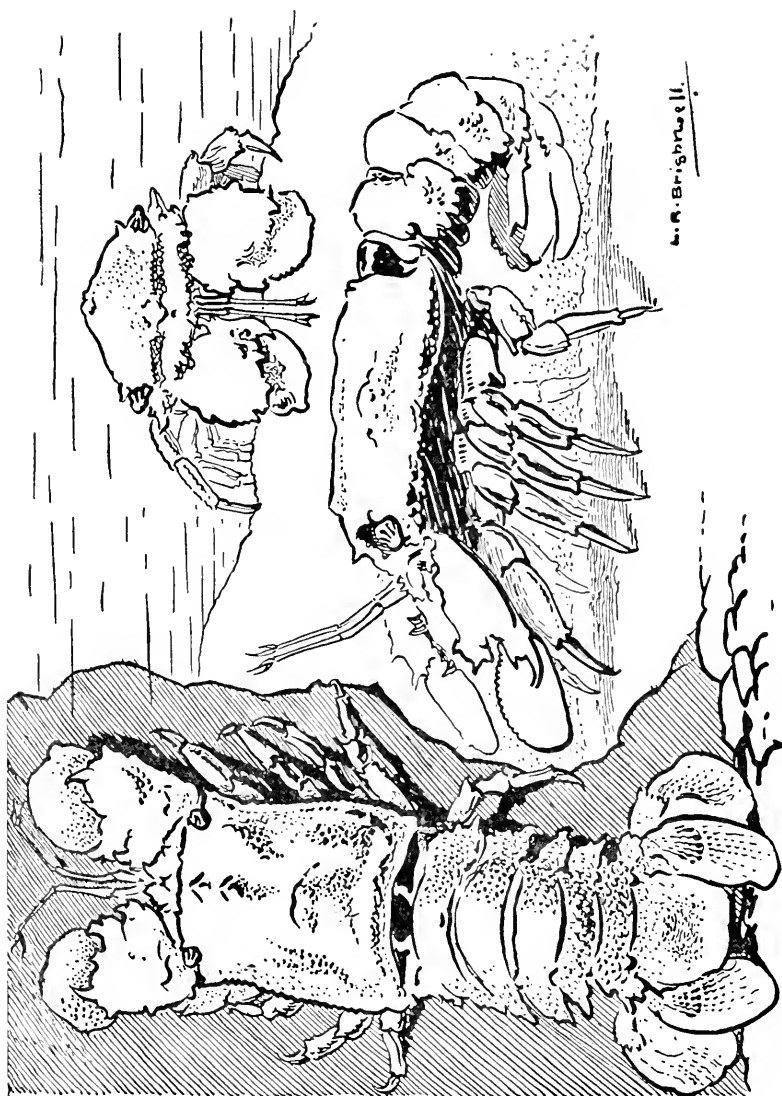
Recent researches have shown that the long-tailed crustacea, though like the other groups without any true hearing apparatus, can "tune in" or at least pick up vibrations in the surrounding water by means of certain "auditory hairs" fringing their legs. These convey the



CRAWFISH (*Astacus*)



LANGOUSTE (*Palinurus vulgaris*)



Flat Lobsters

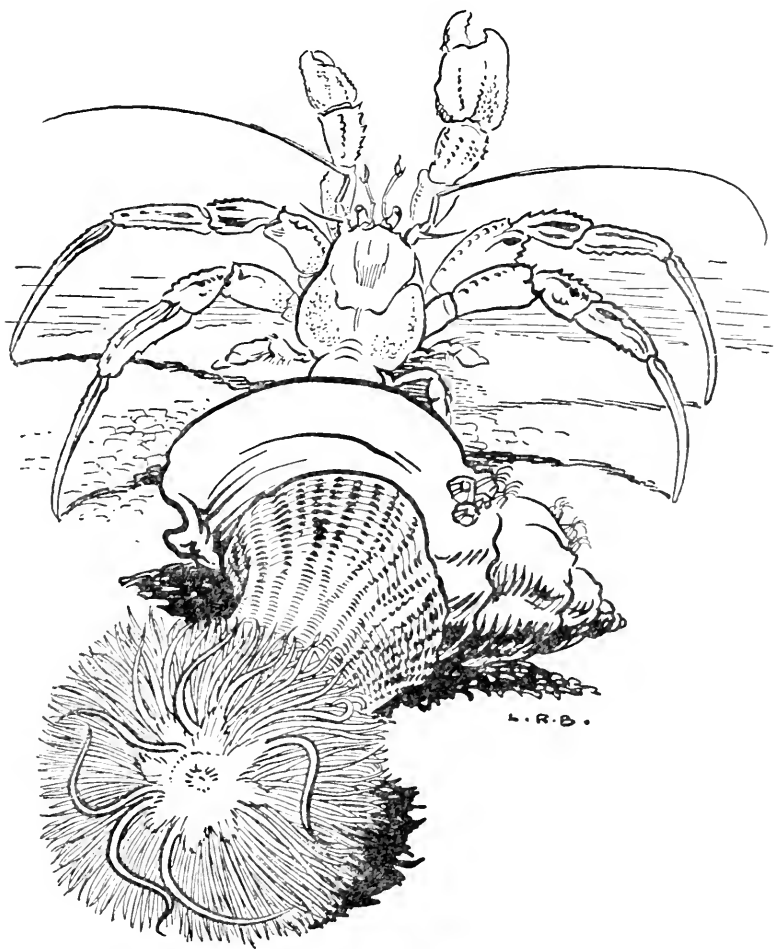
vibrations to the brain via the central nervous system, and it is possible therefore that the crawfish's stridulating proclivities may have some definite significance in bringing the sexes together.

The larvæ of both the crawfish and flat lobster are wholly unlike those of other groups, and their true identities have only been discovered comparatively recently. They are known to fishermen as glass crabs.

The Snap Lobsters (*Alpheus*) are small lobster-like crustaceans which advertise themselves in a remarkable manner. The large claw has a trigger-like arrangement of its movable finger and this being suddenly released produces a loud snapping sound. Dr. William Beebe has recounted how certain tropic sponges were so riddled with these crustaceans that the animals in their agitation, on being brought to the surface, relieved their feelings in what sounded like a veritable burst of Chinese crackers.

The Anomura show many features common to both crabs and lobsters and the members of the group may bear a superficial resemblance to either one or the other. The best known are the remarkable Hermit Crabs. Nearly all Hermit Crabs ensconce their soft and largely unprotected abdominal region in the discarded shell of univalve molluscs, the growth limits of the various species being controlled by the sizes of the shells available. As already mentioned, the shell may also be shared by anemones or sponges, whilst hydroids, barnacles and various worms may also figure amongst the crustacean's camp followers. All the members of the group are exceedingly active and pugnacious.

Some tropical forms of prodigious strength carry



Hermit Crab with Anemone attached

shells many times their own weight, yet come ashore and ascend high shrubs, where they raid the nests of birds for

the sake of the eggs and nestlings. The famous Coconut Crab (*Birgus latro*), of certain islands of the Indian Ocean, is a giant hermit whose great strength and natural enemies have caused it to dispense with all extraneous encumbrances. The largest form inhabits Christmas Island, where it excavates deep burrows, lining these with coconut fibre. The crab ascends the highest palm trees for the sake of the nuts, which it opens by attacking one of the "eyes" and through this narrow opening extracts the kernel. Curiously enough captive specimens resolutely refuse to touch coconut in any shape or form, preferring meat offal, particularly dead rats. Competent observers' statements of this crab's strength can scarcely be exaggerated. Darwin found that one confined in a stout biscuit tin escaped by turning down the inside edges and punching large holes in the metal.

The crab has a devouring but quite aimless curiosity, entering bungalows via the windows and decamping with boots, shaving brushes, etc., with which it later ascends high cliffs or trees. The crab is in much demand for food, whilst the mass of fat covering its tail region yields a quantity of clear oil. The Coconut Crab is diurnal, visiting the sea at night to moisten its gills and also for the deposition of its eggs.

Nearly related to the hermit crabs are the Swim Crabs abundant in northern climes, even in the Arctic seas, where the Eskimos fish for them through holes cut in the ice.

The handsome Squat Lobsters (*Galathea*), well represented in our seas, are lobster-like in form though betraying their hermit crab affinities in the reduced fourth pair of

legs, which are used mainly for cleansing the other appendages. Like most crustacea they are scavengers and bellicose to a degree.

The Brachyura or Short-tailed Crustacea comprise a vast legion known as the true crabs, and are built upon the same lines as the Long-tailed Crustacea, both externally and internally. Like the lobsters and hermit crabs they have a large membranous stomach, and like the lobsters are virtually omnivorous. The tail, however, is doubled under the body and is broad in the female and narrow in the male. True crabs not only abound between tide marks but have also penetrated to the abyss, some having adapted themselves to an entirely pelagic existence in the surface waters, whilst others have travelled far up the rivers and even invaded the dry land. This great range of environment has inevitably involved great diversity of form and habits, and the group has been altogether more completely studied than many other branches of the crustacea.

The crabs are divided into five main groups or tribes. The first includes the most primitive members and are known as Sponge Crabs, of which one species is commonly found off our southern coasts, usually in fairly deep water. It is a slow-moving, clumsily-built creature, with its last two pairs of legs so constructed that they serve to hold a sponge or shell over the creature's back like a canopy, and thus hidden from foes it goes its way though considerably hampered.

A remarkable member of the group has been added to the British fauna only within the last few years. It is a giant amongst crabs, having a leg span of nearly 48

inches. It has been dredged in deep water from the west coast of Ireland and Scotland.

The members of the group known as Sand Crabs may be distinguished by the triangular shape of the mouth area, which is so arranged that the channels carrying the outward stream of water from the gills are produced forwards to the front of the head, so that breathing is facilitated as the creature lies concealed in the sand.

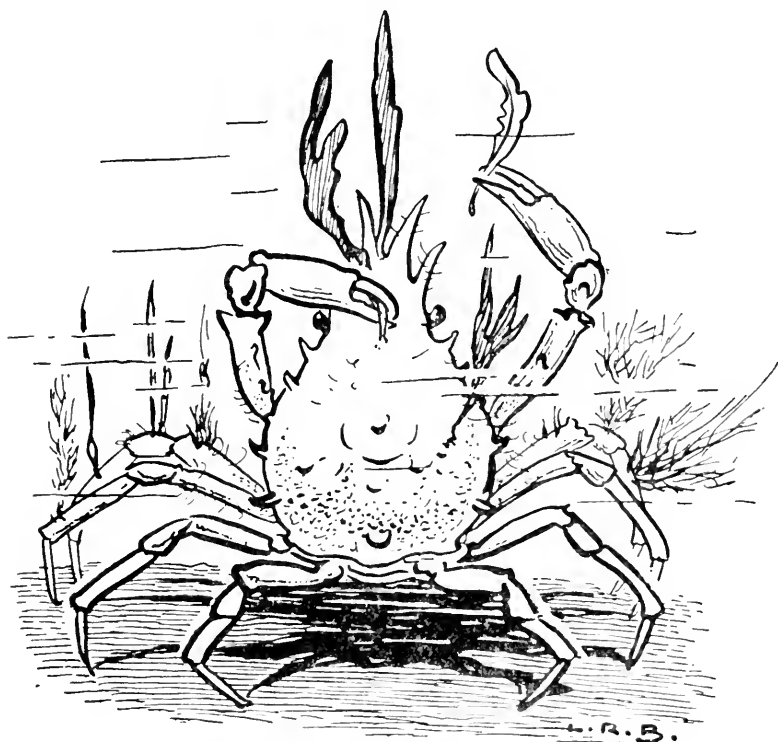
The Bashful Crabs (*Calappa*) are so called from the huge leaf-like form of the pincers, which are held so as to completely hide the countenance. This provision, however, is less the outcome of shyness than of the necessity to keep the sand from entering the mouth and breathing channels. Moreover, the crab when thus folded upon itself presents such a compact and rounded formation that it can be rolled upon the sea floor in a ground swell without suffering the slightest inconvenience.

In the Spider Crabs, which rank among the most remarkable of all crustaceans, the carapace is roughly triangular and the limbs are prolonged, often to a most grotesque degree. Despite this length of limb the animals are lethargic to a degree, and rely for safety almost entirely on their genius for "camouflage."

In some forms, such as the Arrow Crab (*Leptopodia*), the creature is so coloured as to closely resemble weed or coralline thickets, and as a result finds outside aids to disguise superfluous.

Many other Spider Crabs, however, have been forced to excel in the art of dressing up whereby to evade their many foes, and some striking examples are common around all our native shores. The little *Macropodia* for example

is, like most of the group, covered with stiff hooked bristles and these serve as an anchorage for the weeds, etc., with which the crab bedecks itself. Despite its almost negligible mentality it shows an astonishing



Spider Crab (*Pisa*) dressing itself with seaweed

intuition as to the fitness of its disguise. A crab finding itself among green weeds for example neatly cuts off sections with its pincers and chews the ends of the fragments in order to obtain a better grip. The chewed end is then planted firmly amongst the bristles, where it takes root,

and in time these cuttings may flourish to such an extent that the crab presents the appearance of a magically animated bush of seaweed. If such a crab bedecked from head to foot in green weeds be suddenly placed amongst red weeds a remarkable transformation takes place. The creature seems to realise at once that it is no longer "in the picture" and sets about undressing itself and substituting red weeds for its discarded green attire. Such a complete transformation may be effected in a few hours.

Some of the species have a "pipe clay" surface to the shell, on which sponges, sea squirts, etc., find a natural anchorage; whilst others slowly and painfully pile pebbles upon their warty backs, a task involving infinite labour, especially if the stones are smooth and slippery.

All the larger species of the group are edible and caught in a variety of ways. Our native *Maia squinado*, having a limb span of 2 ft., habitually buries itself in shingle and in the Channel Islands fisher-folk walk the gravel reaches on their bare feet, the spines of the crab's back notifying a "catch" to the unprotected soles of the fishermen.

The giant of the race hails from Japan, where an adult male may span 11 ft. across the outspread arms. This monster frequents deep water, but periodically enters shallow bays, where it is taken in specially constructed traps. The creature necessitates cautious handling and fishermen commonly bind each limb to the spokes of a carrier like a huge cart-wheel. Killed and cooked the crab is dismembered and sold at so much per joint.

The Furrowed Crabs (*Xantho*) are curiously wrinkled and shrunken, which give them a spurious appearance of great age. Closely related is the gigantic *Pseudocarcinus*

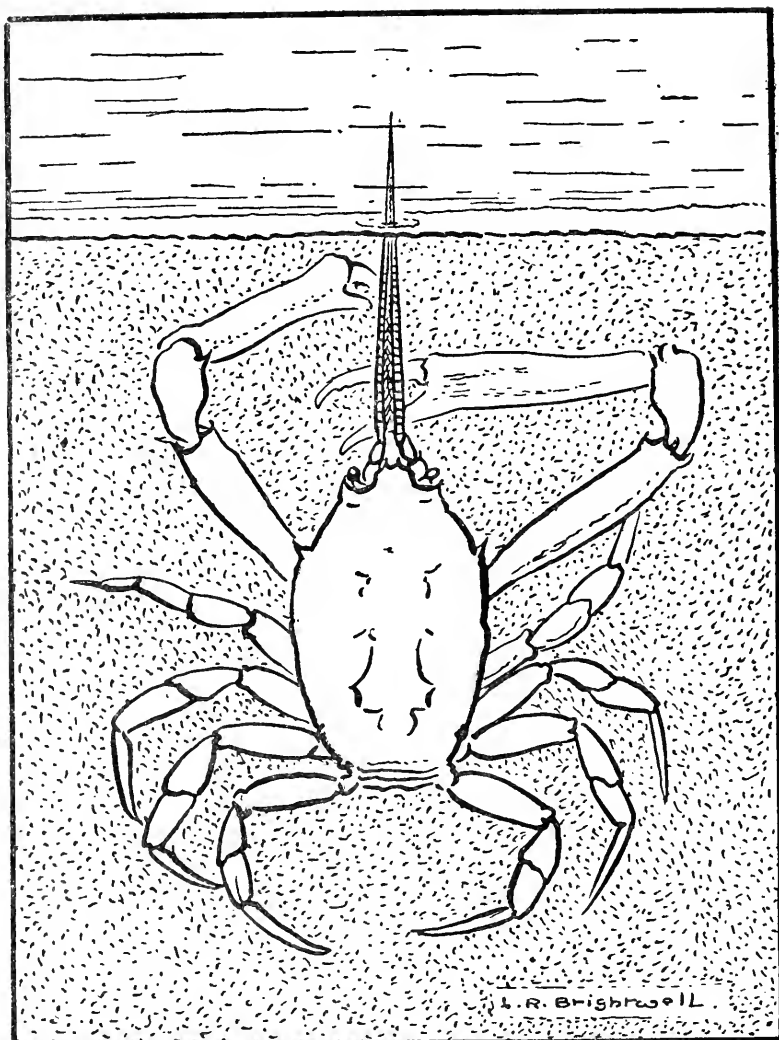
of Tasmania, which has a carapace of a foot across, large males developing the claw to a length of 30 inches. Gruesome stories are told of hapless castaways being killed and eaten by packs of these crabs.

Swimming Crabs or Fiddler Crabs (*Portunus*), represented by seven British species, are all characteristic in the flattened form of the last pair of legs. These are moved at a great rate, giving the popular title of Fiddler Crabs, and enabling the creatures to take long skimming "flights" through the water. The handsome *Henslowi* habitually favours the surface waters in calm weather, actually giving chase to and attacking such active fish as the mackerel and pollack. There is an extraordinary inequality in the sexes in this species. Although many hundreds of thousands of males have been taken by the fisheries research station at Plymouth during the last forty years, only two females have been recorded throughout that period. Over 5,000 males were once taken in a single haul, which contained no females, by the research vessel attached to the Prince of Monaco's Aquarium.

A remarkable tropical form (*Podophthalmus*) has the eyes mounted on stalks suggestive of a snail's horns.

The masked Crabs (*Corystes*) are represented on our coasts by one species of a very curious form. The male has enormously long claws, and in both sexes the antennæ are each furnished with a double row of stiff hairs. These when brought together form a four-sided tube through which the crab can breathe in deep water whilst lying securely concealed beneath the sand. It is exceedingly abundant on all our more sheltered southern beaches.

The Land Crabs are widely distributed in all tropic



Sectional drawing illustrating Masked Crab (*Corystes*) breathing through antennae whilst buried in the sand

lands and often congregate in vast numbers. They frequently penetrate far inland, only making an annual pilgrimage to the sea for spawning purposes. On a certain spring day the entire community, which may spend some weeks previously in "mobilising," start on their trek. Once the seaward march is begun nothing is allowed to bar the progress of this terrifying cavalcade. All other creatures give them the road, whilst houses or other obstructions met with *en route* are unhesitatingly invaded. The noise of the shells knocking together has been likened to the rattle of a troop of cuirassiers. Land Crabs are much esteemed as food in various parts of the world.

Nearly allied to the true Land Crabs is the genus known as *Grapsus*. It is well represented all along the Mediterranean shores and the coast of Africa, and the members seem to be gradually invading the dry land, though never going far from the sea. These crabs are extremely bold and inquisitive, and a visitor sitting quietly on the shore may have his pockets invaded and the contents overhauled.

Closely allied to these progressive crabs is one very remarkable form which never sets foot ashore. This is the Floating Crab (*Planes*). Unlike its allies which excavate burrows for themselves ashore, this species lives out its entire life in mid-ocean, chiefly in the Sargasso Sea, where it wanders amid the dense masses of the Gulf weed. Specimens are sometimes but rarely carried to our southwestern shore. The crab may lay claim to fame since according to legend Columbus heartened his crew by assuring them the crab betokened the close proximity of land, an unwitting deception which nevertheless had the desired effect.

Various species allied to the Land Crab have invaded fresh-waters and of late years the so-called Mitten Crab (*Eriocheir*) has achieved a disagreeable notoriety. Originally believed to have come from Japan, it is now well established on the Continent, notably in the Elbe, where it does much damage by tunnelling river banks. A more sensational feature of the crab is the fact that it has now been established that it is an intermediary host of the river fluke responsible for a form of tubercle. Its use as human food has, as a result, now been prohibited.

The Calling Crab (*Gelasimus*), widely spread over all the warmer coasts, is distinguished by the huge development of one of the male's claws. This feature is used for fighting and also to close the mouth. It is further of special sexual significance, since it is brightly coloured and flourished with much ceremony for the contemplation of a prospective bride. A species of *Gelasimus* is the subject of a remarkable fishery off the coast of Portugal. The fishermen simply remove the large claws of the males, liberating the despoiled owners, who proceed to grow fresh claws, though these never attain to the original proportions.

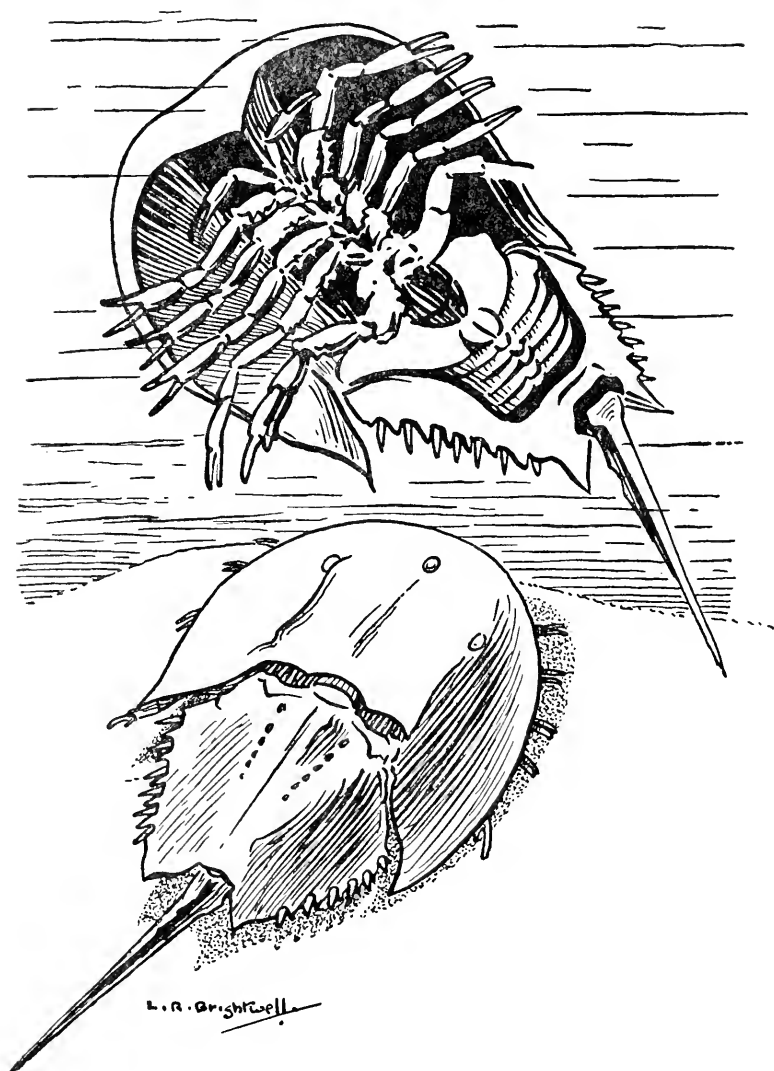
The Pea Crabs (*Pinnotheres*) constitute a strange group of degenerate little crustaceans that have taken to a life of commensalism. The female of our native species almost invariably seeks shelter within a bivalve mollusc such as an oyster or mussel, and as a result of thus refusing to face the buffetings of chance its carapace has become membraneous, whilst the limbs have dwindled and become almost useless. The male, however, remains active and

independent, only visiting its bulky but helpless partner during the breeding season. Various exotic forms similarly quarter themselves upon sea squirts, sea urchins, or the cavities in corals.

A very large number of insects and spiders have their being in a maritime zone, a few entering the salt waters. For the purpose of this book, however, the only remaining groups to be discussed are creatures standing midway between the true crustaceans and the spiders and their allies.

The King Crab (*Limulus*) is an arachnid-like animal of ancient lineage, which enjoyed its heyday during the Jurassic Period many millions of years ago. Its nearest kin are certain marine scorpion-like creatures, some of enormous size, which disappeared with the dawn of terrestrial vegetation. Few species of King Crab survive to-day, and they are confined to coastal areas of moderate depth on the eastern coast of South and Central America and in the East from the Bay of Bengal to China, Japan, the Torres Straits, etc.

As shown in the text-figure, the King Crab has a segmented body with paired limbs entirely covered by a large dome-shaped carapace suggestive of the teutonic military "tin hat." The sexes are distinguished by differences in the fore limbs and in both the upper surface of the carapace bears a median eye in addition to the lateral organs of vision, the third eye being more apparent in young specimens than in old ones. The long tail spine is of service in righting the animal when, as frequently happens, it turns turtle.



King Crabs

King Crabs burrow in the sand searching for worms, etc., and often swarm in the waters. Their very complete armature coupled with their negligible edibility has rendered them almost immune to enemies, though large swordfish and devil rays sometimes eat them. In the spring and early summer the King Crabs run ashore to pair and deposit their eggs in holes, which they scoop out and leave for the incoming tide to fill. The eggs hatch in about a month, and the larvæ do not develop the terminal spine until their first moult. King Crabs appear to be amongst those creatures which no amount of commercial ingenuity can turn to account.

The strange marine animals known as Sea Spiders (*Pycnogonida*) are by some called true spiders, although zoologists are still much at variance as to their exact place in the scheme of life. All are marine and they range from shallow water to forms frequenting depths of 2,000 fathoms. They are particularly abundant in Arctic and Antarctic latitudes. A number of species are abundant in home waters, where they seldom intrude themselves upon the general notice. As the popular name implies, the general form suggests a terrestrial spider, but the limbs are proportionately much longer than those of any known spiders, the body indeed being so reduced that offshoots from the internal organs are accommodated in the legs. Most of our native species are not more than an inch across, but some of the abysmal forms span more than a foot across the outspread limbs. The sea spider has a long proboscis, which it plunges deep into its prey, usually a Coelenterate of some description, and several of our native species are often found attacking anemones

and hydroids. In the sea spiders the males show a surprising solicitude for the safe development of the eggs, the ova being carried about by means of a specially modified but diminutive pair of legs.

CHAPTER IV

ECHINODERMS

THE Echinoderms include the Sea Cucumbers, Sea Lilies, Sea Urchins and Starfishes, and are without exception confined to salt water. The name is derived from the Greek "hedgehog skin" or "spiny skin" and applies aptly to most members of the group, since their skins are covered with spines of carbonate of lime.

Sometimes the internal skeleton is scattered as in all sponges and many soft corals, but frequently the spines and plates unite as in the Sea Urchins to form a shelly "test" or box enclosing the entire animal. Although Echinoderms vary enormously in outward form all are built upon a radial pentagonal star pattern, though this is not apparent in the larval stages through which most forms pass before reaching maturity.

The internal structure is much more complex than in the Coelenterates. There is a well-defined intestine and a complex system of canals which fill hollow muscular tubes with water, by means of which the animals progress. Echinoderms live at all depths and in all climes, some of the giants of the race emanating from the tropics and arctic circle, and from the shallows to the uttermost depths. The larvæ are hatched from eggs and progress

by lashing the water with innumerable hairs or cilia, before settling down upon the sea bed. Some are scavengers and the majority are highly predacious.

The Sea Cucumbers (*Holothuria*) and Sea Gherkins (*Cucumaria*) have elongated bodies of more or less cucumber form, the entire end carrying the mouth surrounded by five or more appendages suggesting ragged fingered hands, which seize food particles and pass them into the creature's interior.

The Arctic seas abound with monstrous forms which may measure two or three feet in length when fully extended. On our coasts the commonest is the Sea Gherkin (*Cucumaria saxicola*), of milky-white colour with delicate lilac "hands." It usually hides in rock crevices, but sometimes ventures forth to "walk" some distance by means of the five rows of tube "feet," which are arranged evenly around the body. On molestation this and others of the group withdraw the "hands" and tube "feet," the whole subsiding into a mere cylindrical lump of inert matter.

The Cotton Spinner (*Holothuria niger*) is a large species from deep water. It is chocolate in colour and has the tube feet arranged not in rows but scattered irregularly over its foot-long body. On being sufficiently irritated the creature throws out vast numbers of white adhesive threads. So numerous and strong are these that a fair-sized lobster once enmeshed in them may be literally bound hand and foot, despite its vigorous struggles.

Sea Cucumbers, like other Echinoderms, are subject to all manner of parasites and camp followers. A Mediterranean species is commonly infested by a small fish—(*Fierasfer*)—that passes in and out of the *Cucumaria*'s

body cavity at will, living apparently with its strange host in a state of commensalism.



Sea Gherkin (*Cucumaria*)

Sea Cucumbers play a very important part in the steady dissolution of coral reefs, which takes place almost as fast

as they are built up. Although so soft and apparently helpless the Sea Cucumbers swallow masses of coral fragments and dissolve them into mud within their bodies. One species even swallows large fragments of coral rock and later throws them up as castings of pulverised limestone.

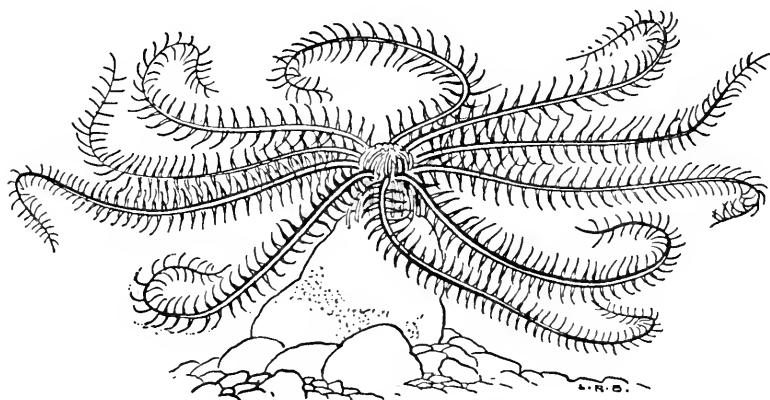
Sea Cucumbers swarm on the surface of the Barrier Reef, and at low tide immense quantities are gathered for the Eastern markets. Innumerable subspecies and grades are recognised by the people of the East, to whom the cucumber or *Beche de Mer* is as great a delicacy as the oyster is to occidentals. The animals are taken ashore in baskets, split open, gutted, washed and spread out in the sun to partially dry. There follows 24 hours smoking, at the end of which time the 2-ft. long sea cucumbers are reduced to some 10 inches in length, and suggest charred sausages, and in this condition they are sent to their innumerable consumers. When boiled they swell to huge proportions and are highly gelatinous, a quality which is much appreciated in the East, where any food of a glutinous nature is deemed a source of virility.

Starfishes, whilst in general form conforming to the accepted pentagonally-rayed pattern, still present endless variations, all of which, are however, fundamentally alike in structure. Before reviewing the true Starfishes, however, attention is directed to the *Crinoides* or Feather Stars.

The group is of immense geological age and was at one time world-wide in distribution, whereas to-day a few species only are known of relatively small size and

confined mainly to the abyssal ocean. In prehistoric times vast areas of the sea floor must have presented the appearance of being covered with 12-ft. or 20-ft. palm trees, whose branches clutched restlessly at the water above and having caught small organisms, passed them to a hungry mouth in the centre of the leaves.

The Crinoides or Sea Lilies are not unlike the Starfish, having five pairs of feathery arms with a mouth pointing



Rosy Feather Star (*Antedon*)

upwards, the whole poised upon a long jointed stem firmly anchored by rootlike outgrowths to the sea floor. A few are without stalks and have free locomotion, but the majority are anchored for life. This interesting group is represented in the tidal zone of our south-western shores by a single species only—the Rosy Feather Star (*Antedon bifida*). It has ten jointed feathery arms which move always in pairs and can row the creature here and there, whilst when desiring to rest a tuft of rootlike

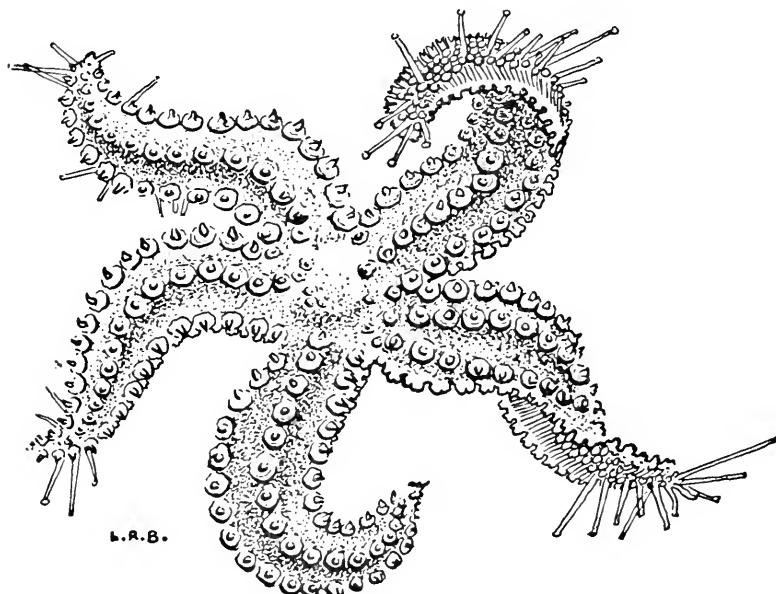
appendages on its undersurface takes a firm grasp of some convenient stone or seaweed. The whole animal is of a delicate "blush rose" or mauve tint and presents a beautiful spectacle when gathered together in large quantities. Fully-grown specimens are about four inches across.

The creature's ancient ancestry is evinced in its early days, when, like most animals, it bears a strong resemblance to its primitive forerunners. It begins life as an elliptical larva, which propels itself by means of hairs and after a time anchors itself by one end to the sea floor, when its upper portion develops a jointed limey stalk tipped with a crown of ten feathery arms. Each arm bears throughout the entire length of its upper surface a groove lined with myriads of lashing hairs that keep a constant current of water flowing towards the central mouth, thus bringing food particles within its grasp. The Sea Lilies live thus for some time until at last the branched arms with a mouth at their centre break free and lead an active wandering life, leaving the stalk behind.

The True Starfishes have the mouth and grooves arranged in much the same manner, but with the leaves turned downwards in the opposite manner to the Sea Lilies. The stomach and other organs lie in sections within the arms, whilst the grooves are lined with four rows of hollow "tube feet," which by being alternately filled or emptied of water propel the creature over the ground. The armature may be in the form of scattered lime crystals, as in our Common Starfish, or form a jointed continuous coat of plates as in the Sand and Brittle Stars. All are predacious and the rays may be attenuated to mere

whip lashes or be so broad and blunted as to give the creature an almost circular outline.

Starfishes like many invertebrates have the capacity to reproduce lost portions highly developed. A single arm torn from a living starfish soon grows four more like



Starfish (*Asterias*)

itself, and whilst these are still much shorter than the original the animal is then said to be in the comet stage. Oyster fishermen, who justly hate the starfish for its ravages on their beds, once used to tear the animal into pieces, throwing them overside—a procedure which had the effect of increasing the pest rather than eliminating it.

The young or larval starfish—very unlike the parent

form—are hatched from eggs that are either cast adrift or anchored to some stable object.

The intake of some of our Common Starfish—(*Asterias rubens* and *A. glacialis*, both abundant off our shores)—is prodigious. Specimens only six inches across the arm will stretch themselves about a whelk and then, extending their stomachs, devour the victim. It attacks oysters and scallops by applying the suckers of three arms to one valve and of two to the other, and then “pulling against itself.” At the same time the stomach is everted and the digestive juice is brought to bear on the slowly widening gap between the valves.

Our largest native species of Starfish (*Asterias aurantiaca*) from deep water measures nearly 30 inches across. One species of Starfish (*Luidia*) is cannibalistic, and by preying on the Common Starfish keeps some check upon the pest.

Starfishes present a wonderful range of colour, some, such as the Twelve-rayed Sun Star (*Solaster papposus*), being as gorgeous as any dahlia or carnation. The so-called Cushion Stars (*Porania pulvillus*) are legion both as regards numbers of individuals and species, and range in size from an inch to two feet or more in diameter.

Most of the forms mentioned above are rock dwellers, but the attenuated Brittle Stars affect a sandy or gravelly bottom.

The Sand Stars (*Ophiura ciliaris*) have an almost circular body with jointed arms sharply defined. Instead of creeping steadily forward on tube feet, they stride over the sea floor by throwing the arms forward and then thrusting vigorously backwards.

The Brittle Stars (*Ophiocoma*) are not unlike the Sand Stars, but the arms are much longer and are densely fringed with needle-pointed spines. Our largest species, *O. niger*, shows a most wonderful diversity of colouring and pattern, scarcely two specimens being found exactly alike. These and the Sand Stars part with their arms on the slightest provocation.

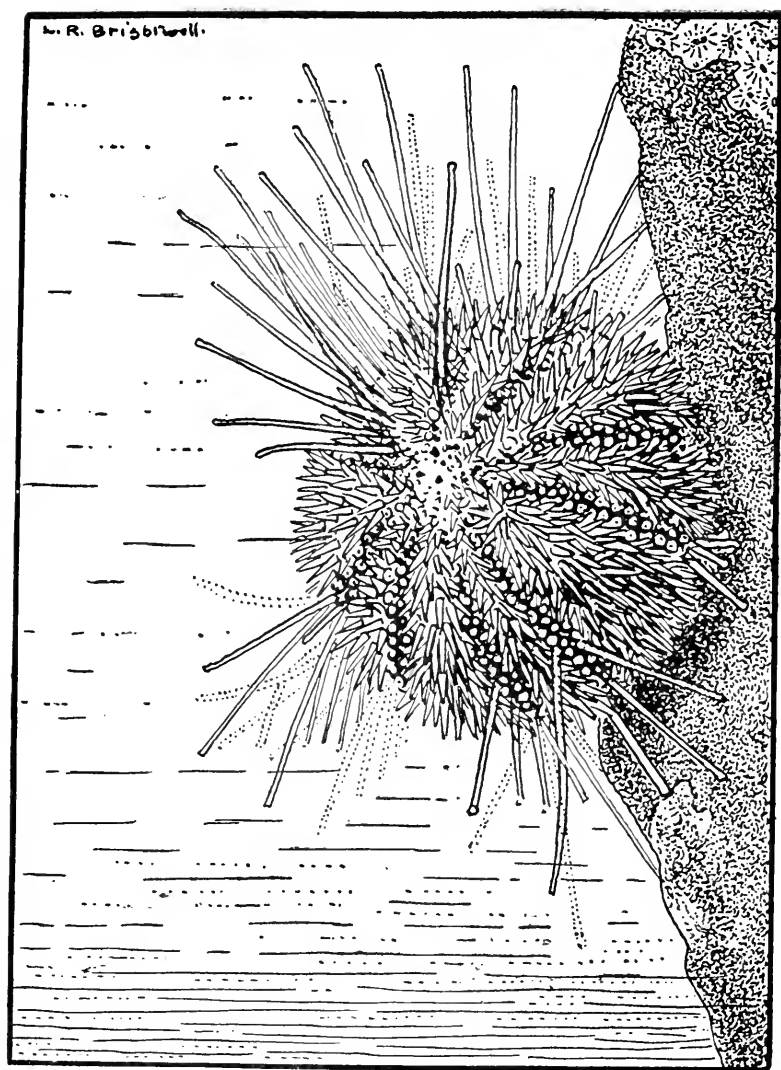
Most striking of all the Starfishes are the Basket Stars (*Euryalidæ*), abundant in most seas at almost any depth below the 100 fathom line. The typical five rays are divided and subdivided until they give rise to thousands of terminal branches. The Basket Star walks upon the tips of these branches seeking its prey, and food not infrequently comes to it in the form of fishes who seek shelter amongst the tangled arms, mistaking them for weed thickets.

At first glance a SEA URCHIN has little in common with any of the creatures just described. Examination shows, however, that it is built upon the five-rayed pattern and that although the animal is encased in a flattened or spherical shell, this is pierced by numerous holes, through which tube feet are thrust, by means of which the creature progresses at an even pace over horizontal or vertical surfaces with equal facility. In addition to the features shared with the starfishes and Sea Cucumbers, Sea Urchins differ in several important points. Besides the tube feet, the outer shell or test is usually provided with numerous spines often of great length and either sharply pointed or club-shaped. These spines are each mounted on a ball and socket joint and can be moved within a certain radius,

thus aiding progression besides keeping foes at a distance. Between the spines and tube feet are thousands of other appendages which can be thrust outwards through the minute port-holes. These extra appendages are generally recognised as being of three well-defined patterns. Some are like pincers mounted on long stalks, and these being very active and mobile quickly seize and destroy any minute creature which might injure the skin. There are also bulb-headed pincers armed with poison glands for use in defence. And thirdly, snake-headed pincers, their jaws armed with fringes of needle-like teeth, which are particularly used to hold active prey. The surface of a Sea Urchin, indeed, seen under a lens presents an extraordinary spectacle of restless activity, and an active creature such as a sandhopper falling amongst the forest of swaying tube feet, spines and other appendages is instantly detained and hustled over the creature's surface till it reaches the circular mouth upon the underside. Here it meets with five large grinding "teeth," which are supported by a most complex structure known as "Aristotle's lantern," since it is not unlike an archaic lamp and was first described by the Greek naturalist and philosopher. The "lantern" is composed of some fifty hard limey structures neatly interlocked and combining to form a most effective grinding mill. Certain tube feet near the mouth are employed solely for tasting.

Sea Urchins abound in most seas and often hollow out vast cavities in the limestone, where they lie embedded for long periods.

The Sea Egg (*Echinus esculentus*) is somewhat larger than a man's fist and on the Continent is esteemed as food.



Sea Urchin (*Echinus*) climbing rock

In spring the female produces masses of pinkish ova ranged on the inside of the shell, and this has a pleasant flavour. When ripe they are discharged into the water as minute larvæ, which pass through many complex metamorphoses before attaining the parent form. A single Sea Urchin may produce 20 million young.

Many foreign species have enormously long spines, whilst in one family the spines are stout, cigar-shaped structures.

The Heart- or Sand-Urchin (*Echinocardium cordatum*) has a flattened heart-shaped shell with five curved spines, but no trace of the "lantern" or jaws and teeth. The spines may be used to shovel the creature below the sand, where it makes a burrow about nine inches deep connecting with the sea floor by a narrow opening. Certain of the tube feet act as respiratory organs, whilst those used for catching food may be extended to several times the length of their owner. Many Sea Urchins do considerable damage to oyster and scallop beds, smothering the bivalves or drilling holes through their shells by means of their sharply-pointed "teeth."

Certain Urchins known as Shelled Urchins in this country are much flattened and not more than $\frac{1}{4}$ inch from back to front. Owing to their compressed form they cannot right themselves when inverted, and it thus happens that many thousands are cast ashore during gales. In America these Urchins are known as "Sand Devils" and are sometimes pounded down to make an indelible writing fluid.

Although its representatives are only related to the

Echinoderms by their development, I propose to mention here a very remarkable group of animals of which the type is *Balanoglossus*. The animal is a pink or orange worm-like creature varying according to species from a few inches to several yards in length. It is a sand burrower, making a long U-shaped shaft in the sea-bed, one end sometimes ramified into several divergent branches, giving free access to the water. The animal lays eggs which hatch into larvæ bearing a strange resemblance to the larvæ of Sea Urchins or Starfish, but the adult into which they finally transform has a number of points in common with the vertebrates. It is in fact generally relegated to the phylum *Chordata*. It possesses for instance a tubular structure—a problematic notochord—and numerous gill-slits, and has no radial symmetry as have the Echinoderms.

The members of the family abound in tropic seas and one species is common in the Channel Islands. The latter is remarkable for a powerful odour of iodoform, which pervades the creature's burrow and an area of some yards' radius all around it. So tenacious is this odour that it clings to the hands for days despite repeated washing.

Somewhere between the Echinoderms and the Mollusca, scientists have agreed to place that world-wide group of animals known as BRACHYPODS. Several forms from deep as well as shallow water are known off our shores. Superficially the Brachyopod resembles a clam or oyster. Its two shells, however, are not, as in bivalve molluscs, placed one on either side of the creature, but are arranged so that one shell is on the back and the other underneath.

The upper shell may have a downward opening apex pierced with a hole, through which passes a strong ligament, anchoring the creature to rocks or reeds. Within the shell one finds two coiled arms or feet which have respiratory functions, whilst the food is washed towards the mouth by currents set in motion by lashing cilia.

In the remote times Brachyopods, or "Lamp Shells" as they are called, from the shape of the upper valve, abounded in every sea. To-day the group is much reduced and widely scattered in depths of water varying from less than a hundred to nearly three thousand fathoms. The majority are of a dead white, but certain tropical forms are resplendent with beautiful greenish or peacock tints.

CHAPTER V

WORMS AND POLYZOA

THE average person with no special leanings towards natural history has little knowledge of the animals collectively spoken of as "worms," and has even less inclination to increase his slender acquaintanceship. The word "worm" has become synonymous with all that is undesirable, and a few species, such as the earthworm, the leech and certain parasitic species, embody the entire group so far as the general public is concerned.

Yet the worms are of direct biological significance, and possibly no other group of animals so obtrudes itself upon human destinies and that not the less potently because unnoticed. Owing to the soft and yielding nature of most worms few have perpetrated themselves as fossil remains ; yet there is little doubt that worms were amongst the earliest manifestations of animal life, since certain intermediary links in the chain of evolution point to the fact that the worms formed one of the starting points for the higher forms of existence.

The worms have insinuated themselves into every kind of habitat. They abound in the earth, in fresh water, and in the sea. They occur in all countries and all climes, from the equatorial belt to high above the snow line. The most primitive of these are the Flat- or Whirl-

Worms (*Turbellaria*), as they are called after the flattened leaf-like forms and the whirling currents of water set up by the lashing hairs with which they are covered. All are predacious, feeding upon other worms, aquatic snails and crustaceans.

One of our commonest native species is the Living Film Worm (*Leptoplana tremellaris*), common in summer beneath stones, etc. It is transparent, leaf-like and about half an inch long, moving rapidly by lateral movements of its compressed margin in the manner of a skate. It has well-formed eyes and a suckorial mouth on its under-surface, and also the nucleus of a brain. Like many worms, it seems happily indifferent to mutilation, detached portions developing into separate worms ; it reproduces by means of eggs.

Allied to these simple unsegmented worms are the Ribbon Worms (*Nemertini*). The typical Ribbon Worm has a brain, a nervous system, several groups of eyes, and an elongate tubular proboscis. Most of our native species are small, but there are a few striking forms which arrest the attention of the most casual observer. The foremost of these is a worm commonly known as Bootlaces or Living Fishing-line Worm (*Lineus longissimus*). As disclosed beneath some upturned boulder it suggests a mass of calves' liver. In a tank or pool this reveals itself as a smooth silvery worm of apparently limitless dimensions. Specimens of over 90 feet have been recorded, and when such a worm has attached its bell-shaped mouth to a fish the victim is literally played by this living line until it succumbs to exhaustion, and it is then slowly engulfed. The Bootlace Worm reproduces very rapidly by division ;

like most other worms it also lays eggs which pass through a complex metamorphosis.

A few of the Ribbon Worms make tubes and burrows.

To the great order of Bristle Worms (*Polychæta*) belong a large number of species of considerable importance to man since they form the staple substance of many food fishes, and are in great demand as bait. All have the bodies made up of many rings or segments, each segment bearing paired limbs armed with stiff sharply-pointed bristles adapted to such varied purposes as swimming, burrowing, feeling, feeding and even breathing. These worms show bizarre forms and resplendent colouring—some of the most striking being common inhabitants of our home waters.

The Bristle Worms are divided into many families, but here only a number of the more important species can be touched upon. The Common Lug Worm (*Arenicola marina*) is sufficiently well known to every sea angler. It attains to some eight inches in length and makes a U-shaped burrow one to two feet deep. It passes many yards of sand through its body daily, in the manner of an earthworm, the waste sand forming the well-known castings after the worm has extracted all nutritive matter. Like the earthworm it does much to sweeten and circulate the soil in which it lives and it has been calculated that these worms in a single acre of sand may throw up 2,000 tons of waste matter in the form of castings in a single night.

The Rag Worm (*Nereis diversicolor*), another popular “bait,” frequents somewhat more gravelly ground, where it often builds a tube on the inner side of some boulder.

The prismatic nature of the worm's outer cuticle causes it to flash with the most resplendent colours. Like many others of this order it is highly predacious and is quick to use its powerful jaws on the fingers of the fisherman who uses it for his line.

An interesting relative is the chocolate and white striped Hermit Crab Worm (*Nereis fucata*), which is invariably found in association with the common hermit crab. It hides in the uppermost part of the crab's borrowed tenement, and as soon as the crab embarks upon a meal the worm "comes down to dinner" and gliding beneath the crab's busy jaws takes its full share of the feast.

The Sea Mouse (*Aphrodite aculeata*), also known as the Sea Mole, is the Bristle Worm so broadened as to at first suggest a large slug. Despite its dense covering of vividly iridescent bristles it is eaten by many fish. Each bristle is enclosed beneath two limp covers and when the stiff bristle with its barbed edges comes into contact with a soft object, it at once penetrates the surface of the limp cover, crumpling it out of the way. This contrivance is a remarkable parallel to the "stiletto" of the common mosquito. The Sea Mouse is common on sandy or gravelly ground, where it partially covers its upper portion by shovelling up the loose soil.

Allied to the Sea Mouse are the various Scale Worms, with big sequin-like scales arranged in two parallel rows. Scale Worms are to be found on most shores under boulders at low tide, but one species some two inches long habitually hides in the grooves of the undersurface of the common starfish.

The Leaf Worms (*Phyllodoce*) are so called owing to

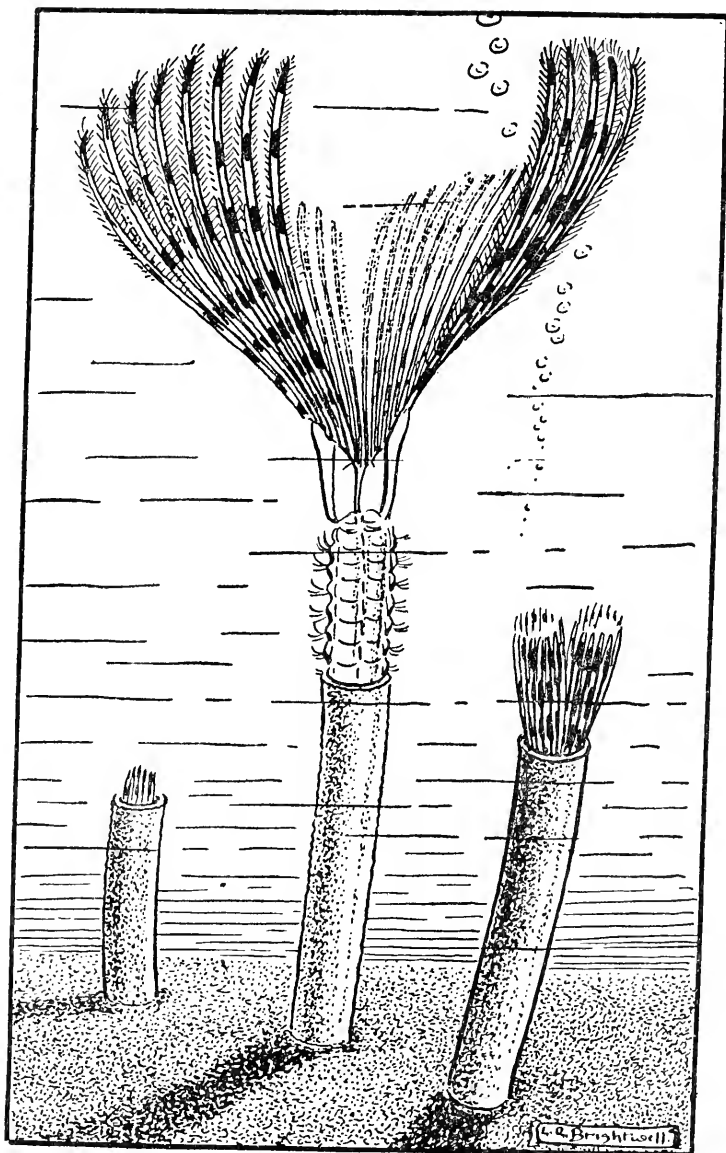
their feet being flattened to form leaf-like structures which aid the worms in swimming. Though they may thus escape general attention, their egg masses must often have puzzled the seaside visitor. The ova are encased in gelatinous balls attached by a delicate thread to leaves or solid objects. The eggs of one common species are exactly the size, colour and texture of a fresh-water grape.

A very large number of Polychæte worms build tubes often of striking formation and varied design. The Quill Worm (*Hyalinoecia tubicola*) makes a long transparent tube the size of and colour of a goose quill and in this the worm hides, excluding intruders by a series of ingenious flaps or valves. It is an active worm and crawls about, dragging its tube with it in the manner of a cadis larva.

Another common worm is the Sand Mason (*Terebella conchilega*), the tubes of which few can have overlooked. They often suggest a clump of corn stubble, each stalk having a crown of ragged arms, the whole composed of sand grains. The worm, like most of the tube-dwellers, obtrudes itself at high water, displaying beautiful feathery gill plumes and a mass of threadlike tentacles which may spread like a golden halo above the tube.

The Peacock Worm (*Sabella pavonina*) similarly raises the upper portion of its tube well above the sand, and as the tide rises spreads a pair of immense gill plumes, the colours of which fully justify the popular name. When all is quiet a cluster of these worms makes a veritable flower garden, but on the slightest hint of alarm or even the passing of a cloud shadow the plumes vanish in a second leaving only the dead-looking corn stalks.

Very few animals may be termed definitely inedible,



Feathery Sea Worm (*Sabella*)

but one might pardonably imagine that worms, terrestrial or aquatic, would commend themselves to none but the starving. A near relative of a British worm, however, is not merely edible, but a highly-prized delicacy in certain islands of the South Pacific. The Palolo Worm is one of the few marine animals whose movements can be relied upon to take a certain course on a given day and at a certain hour. Throughout most of the year the worm hides in holes or crevices amongst the rocks and coral masses of the sea-bed. But for two days in October and again in November—on the day before and the day on which the moon is in its last quarter, the worms appear at the sea surface in such numbers that the water appears to be literally solid with them. The swarms are at their maximum on the second day of each moon, but it is not the whole worm which thus appears, but only the hinder portion of the worm which is heavily charged with the reproductive element. It has now been established that on a certain day all the worms obtrude the hinder parts of their bodies from their various hiding places and these break away and wriggle to the surface, the head portion of the worm creeping back to the burrow. The egg sperm masses being varied in colour many square miles of sea are tinted red, brown, gold, green and indigo. The appearance of these egg masses, so important to the continuance of the palolo race, produces a striking effect upon the humans in the vicinity. The natives, knowing the appointed hour each day, put out to sea with specially-constructed baskets, and the worms being scooped up in these are hurried ashore and rushed to all parts of the islands, since they must be eaten fresh. European

residents appreciate them fully as much as do the natives, and there is no more graceful gift at such times than a basket of Palolo Worms, which are eaten either cooked or raw. Epicures, however, consider that they are spoiled by cooking.

It is interesting to bear in mind that several other marine animals produce ova which are at their best at certain stages of moons. In Egypt a certain sea urchin produces its much-esteemed ova when the moon is at the full. The scallop is believed to behave similarly, whilst the native oyster tends to spate in greater numbers during the week following a full or new moon.

One of the commonest of all tubular worms is the Keeled Tube Worm (*Pomatoceros triqueter*), known at a glance by its white chalky tube having a marked ridge or keel on the upper portion. The worm often forms huge tangled masses which almost obliterate the form of the object to which it is attached, the said object being a weed frond, stone, shell or even a living crab or lobster. The worm protrudes a pair of scarlet gill plumes that on the least alarm are suddenly withdrawn and the opening of the tube closed with a hard shelly door or stopper. The Keeled Worm, one of the commonest of our native species, incubates its eggs in a special incubating chamber beneath the shelly lid and here they remain until the young larvæ force an exit through the wall of their nursery.

Many marine worms are luminescent and none more so than the Parchment Tube Worms (*Chaetopterus variopedatus*) the defunct tubes of which are often cast ashore after a gale. These tubes are khaki colour and of tough parchment-like texture nearly two feet long by an inch or more

broad. The tube is bent into a U and in this resides a four-inch long worm of remarkable form. It has a funnel-shaped head provided with two tentacles and a pair of eyes, nine pairs of lobe-shaped feet and a number of club-shaped segments terminating in feet which anchor the worm to its retreat. The club-shaped segments keep up a rhythmic pumping motion which causes a steady current of water to flow through the tube, aerating the worm's blood and at the same time bringing food to it. The worm is highly phosphorescent and any disturbance in the water intensifies the greenish glow given out of every part of the animal. Of what service this can be to the worm no one has yet offered a satisfactory explanation. The light causes a very obvious halo over the mouth or burrow and advertises the worm's presence to its undoing, for many fish automatically make for the light and either drag out the worm or devour it with tube complete.

The Leeches, so abundant in all fresh waters, are in our own seas represented by only two species. Like their fresh-water relations they are more or less parasitic, chiefly attacking fish.

The POLYZOA—multiple animals—are so named from the fact that they live in large colonies like corals. For many years biologists the world over have been endeavouring to arrange all animals in an orderly sequence, but there are certain forms which seem to have affinities with widely separate groups, and the Polyzoa fall into this category.

To the average man they suggest plants, but the biologist knows them to be comparatively highly-organised animals with a definite gut and body cavity. The bulk of the

Polyzoa are distinctly coralline in appearance and like the corallines are abundant everywhere, over 130 species having been recorded from the coast of Devon alone.

A typical Polyzoan consists of a large number of animals, each an entity and occupying a horny or calcareous cell yet joined to every other member of the community. The colonies multiply by producing eggs which hatch into larvæ and eventually settle down and start fresh colonies.

But here all analogy with the corallines ends. The perfect animals instead of always being replicas of a set pattern, like most polyps, often differ considerably individually. A normal member of a Polyzoa community lives in a cell which is closed by a lid, having the wall pierced with numerous holes through which the animal keeps in connection with its fellows. The creature has a crown of tentacles covered with hairs, which whirl minute food particles into its mouth, instead of grasping food in the manner of a polyp.

As previously stated, the great majority suggest corallines or seaweed growths. The Prickly Sea-mat (*Flustrella hispida*), with its wide flattened "leaves," is very common on our eastern shores, whilst in the south the prevalent species (*Cellaria fistulosa*) popularly known as Bugles suggests masses of the once popular bugle beads.

Membranipora, the Lacework Polyzoan, may be found covering large areas of the common rock weeds with a beautiful gossamer pattern. In striking contrast is the Ross (*Lepralia foliacea*) that forms huge stony masses measuring at times seven or more feet across. Despite its coralline appearance it is exceedingly brittle and as washed ashore is of a dead white colour, but in life with

the animals fully extended it presents a delicate pink appearance.

It may be mentioned that whilst the majority of the members of the group are marine, many inhabit fresh water, and at times are so abundant as to choke large water mains.



CHAPTER VI

MOLLUSCS

THE general term of Mollusc (*Mollusca*) is employed to embrace many varied soft forms and includes the slugs, snails, oysters, squids, octopuses, etc. The group is represented in every quarter of the globe and, so far as marine species are concerned, have even penetrated within the arctic and antarctic circles.

Molluscs are believed to have had their origin in forms nearly related to the Annelids or segmented worms and although many appear to have little in common they nevertheless agree in certain particulars. All have soft unsegmented bodies and there may be an external or internal shell present either in the adult or immature form and often in both. Molluscs have a heart, blood vessels and a complex nervous system. Often there is a fleshy organ which can be used for locomotion and a rasping organ or tongue with which the creature eats.

The great majority of Molluscs carry external shells, and of such over 60,000 species have been identified to date. A large number of these are widely used for food and the shells of many have played an important part in human economics from the earliest times. The mollusc shells supplied man with his first plates, spoons, and currency. Shells are still put to endless purposes of

ornamentation in all countries, savage and civilised ; pearls still have a considerable market value ; and from the molluscs the ancients obtained some of their valued dyes. Shells have played their part in religious customs and beliefs and still do so in some countries.

In the present volume only the marine forms will be touched upon and it may be said that the seas appear to have swarmed with molluscs of all descriptions from remote periods, countless æons before the most primitive of the vertebrate animals came into being. Without entering into the complexities of scientific classification, it may be mentioned that the molluscs are divided into five main classes—each abundantly represented in salt waters.

Class I. Group AMPHINEURA. These molluscs, though abundant, form one of the smallest classes and to the casual observer are altogether unknown. It may have chanced, however, that the seaside visitor whilst searching for crabs or edible molluscs amongst the rocks, has been nonplussed by certain creatures which although having much the appearance of woodlice adhere to the rocks with all the tenacity of limpets. These are the Chitons or “Coat of Mail Shells.” If one is prised from its anchorage it will be seen that the animal is not unlike a limpet in general shape, but has the shell divided into eight overlapping sections, permitting the creature to fold itself in half, thus protecting its defenceless under-surface. Peculiar sense organs having each a retina and lens are attached to the shell itself and the gills are seen as a feathery fringe marginating the animal’s body. Chitons are very abundant, some attaining to large size, though

none of our twelve or more native kinds exceed an inch in length. Like many of the higher molluscs, Chitons have a long ribbonlike tongue with many thousands of "teeth" arranged upon it in rows. This organ is used as a file and can be employed to rasp away vegetation, or even drill a hole in some hard substance.

Some near relations of the Chitons known as the *Aplacophora* are wormlike creatures which have no trace of a shell and live amongst mud, a few apparently attacking corals and hydroids.

Class 2. The GASTROPODS. These include many species whose names are household words. As the term "gastropod" implies the animals have the foot in the gastric region—a broad muscular expanse on the under-surface of the body and by means of which the creature glides or scrambles at varying rates. The animal usually carries a shell, into which it can retreat at will, and often there is a horny or stony cap attached to the hinder portion of the foot which automatically closes the mouth of the shell against intruders. There is usually present a pair of well-defined eyes, two or more tactile organs—tentacles, and the already-mentioned tongue.

The Limpet (*Patella*) is familiar to all. It is of world-wide distribution and is usually found between tide marks. The animal clings to its anchorage with a persistence which has made it a by-word for tenacity. Experiments with a spring balance show that a limpet with a shell one and a half inches in diameter has a resistance of 70 lbs., and thus the adhesive power of some tropical forms which reach a foot across may well be imagined. Limpets

are exclusively vegetarian, feeding chiefly at night and returning to the spot they usually occupy by day with a remarkable persistence that bespeaks a noteworthy sense of orientation. The shell of our own species varies greatly with the locality, and experts can even tell which point of the compass the creature habitually faces by its formation. In the larval stages the limpet has the nucleus of a spirally-twisted shell, suggesting that its shelly home has acquired the well-known "Chinaman's hat" shape in conformation with its peculiar way of life, the flattened conical form being best suited to withstand the fury of the waves.

The Ear Shells or Ormers (*Haliotis*) are familiar to all as ornaments. The shell has a series of openings along the thickened margin and through these tactile organs are protruded. Like all shell-bearing molluscs the Ormer enlarges its shell to accommodate its increasing size by continually adding layers of cement to the outer margin. Since the Ormer requires but five orifices for the extrusion of its feelers, those no longer required are sealed up with shelly material as occasion arises. Ormers reach their maximum size in tropic seas and both shell and animal are in great demand, the one for ornament and the other as a comestible. The animal holds the speed record for Gastropod molluscs, the common species still found in the Channel Islands gliding along at the rate of several feet a minute.

The Top Shells (*Trochus*, etc.), like the Ormers, line their shells with mother of pearl, and in consequence have always been in great demand for ornamental purposes of every description. As with most molluscs the largest

and finest species are of tropical origin. Many close their shells with a door or "operculum" of hard limey substance, which is frequently of brilliant colouring. The once popular cat's-eye brooches were derived from a large Pacific species.

The Periwinkles (*Littorina*) are in this country at least of economic value and the largest examples are derived from Scottish waters between tide marks. The winkles are members of a group of molluscs which is gradually exchanging a maritime for a terrestrial existence, one at least of our native species never entering the sea, but deriving sufficient moisture from spray baths as it clings on the cliff face well above high tide level. In conformation with its peculiar habitat the young are hatched within the parent shell.

The Cowry (*Trinia europaea*) is a member of another familiar group famous for beauty of form and colour and further distinguished for still being a recognised form of currency in some parts of Africa. The animals are even more resplendent than their shells and are of active and predaceous proclivities.

Nothing was known of the Cowry's metamorphosis until 1926, when investigators in France and at Plymouth discovered that the eggs of our native species are laid in vase-like capsules embedded in an Ascidian on which this particular Cowry feeds.

The allied Poached-egg Shell (*Ovula patula*) of home waters is invariably found attacking soft corals, eating the polyps out of their protective coral cups with its long pig-like snout.

The Violet Snails (*Ianthinidae*) come to our western shores

only as chance visitors and their delicate shells seldom survive contact with the beach. These unique sea snails never willingly meet with any solid support, but live floating lives in mid-ocean. Both shell and occupant are of a lovely violet blue. The eggs are laid in spindle-shaped capsules attached to the undersurface of a glistening fairy-like raft composed of a viscid secretion filled with air bubbles and varying from a few inches to a foot in length according to the species. Violet Snails devour jellyfish and when molested cloud the water with a quantity of violet fluid.

The allied *Eulima* have long, white, highly polished shells and the animals are of interest as being parasitic upon sea urchins and other echinoderms. Several forms are native to our waters.

The Carrier Shells instead of attaching themselves contrive to affix stones and other shells to their own edifices, the result being an effective if cumbersome camouflage.

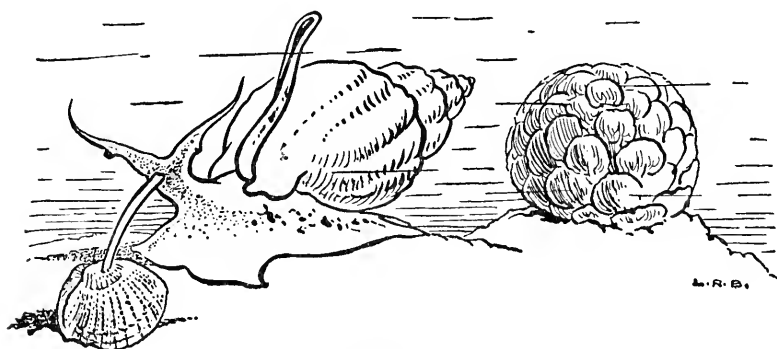
The Wind Shells (*Strombus*) are familiar ornaments of the seafarer's home and in Victorian days were favourite garden ornaments. The huge *Strombus gigas* of the West Indies is in demand for the manufacture of porcelain, over 300,000 being imported for that purpose to Liverpool every year. The Wind Shells, like their nearest British relative the Pelican's Foot Shell (*Aporrhais pes-pellicani*), have the foot prolonged into a stout club by means of which the animal progresses in a series of grotesque hops.

Both the Fountain Shells and their allies the Helmet Shells are of interest in that the shell is built up of a differently coloured layer.

The related Glass Shells (*Carinaria*) have disproportion-

ately small glassy shells and the foot is expanded into a huge swimming organ. Like the Violet Snail they live entirely in the open sea and subsist on jellyfish.

The Whelks and their allies comprise over a hundred species of world-wide origin. All are highly predaceous, using the tongue to drill small holes in the shells of other molluscs and eating out the occupant piecemeal. The eggs are laid within horny capsules, several embryos



Whelk (*Buccinum*) and its eggs

sharing a single envelope. Even at this stage the sanguinary nature of the animal asserts itself, for the embryos prey upon one another, only a single member of each cradle surviving to emerge into the open sea. The egg masses often take very curious forms, those of our own species often being mistaken for sponges and those of the American Whelk suggesting antelope horns. Whelks the world over are valued as food, whilst in remote parts the shells of many are still employed as primitive lamps and trumpets. One whelk at least—the Sacred Chank of

India—is of great importance as a religious emblem, being the object of a special fishery. It is sold by the tens of thousands in Bengal, where it is used in the manufacture of bracelets and anklets. One species of whelk in the tropics (*Fasciolaria*) holds the record for being the largest known Gastropod, specimens attaining a length of 2 ft.

The beautiful Rock Whelks (*Murex*) are very ornamental and display numerous long and strong spines which must deter the most voracious fish. The common Mediterranean species may lay claim to fame as having provided the famous “Tyrian purple”—the rich dye that was once the sole prerogative of kings. This dye is common to all the Rock Whelks, even to our native Dog Whelk (*Nassa reticulata*), and is secreted by special glands. When first extruded it is a pale yellow, but on exposure to sunlight turns green and finally purple. In ancient times this dyeing industry was practised throughout Italy and Greece, and all along the south coast of France one may still meet huge kitchen middens of empty Murex shells, testifying to a fashion long since passed into oblivion.

The big globular shells of the Barrel Whelks (*Dolium*) are common in tropical seas where the animal is unique in its method of attack. Its salivary glands secrete a fluid containing over three per cent. free sulphuric, and fifty per cent. free hydrochloric acid, with which it dissolves the shells of the sea urchins upon which it feeds.

The Coral Whelks (*Coralliophila*) are nearly allied to our active predaceous whelk, but have acquired a strangely sedentary habit. The animal fixes itself, mouth upwards, into a block of coral and then continually extends the

shell opening in order to keep pace with the ever-extending coral.

Shell collecting was a very widely-spread vogue amongst the wealthy of the last century, and extravagant prices were offered for rare or beautiful specimens. The Cone Shells found on most tropic shores have played no little part in the romances of the sale room. The beautiful Glory of the Sea Cone (*Conus gloria-maris*) is unique in this regard. It is believed to be confined to one small coral reef which was disturbed by volcanic action a few decades ago. As a result only forty or more Glory of the Sea Cones are believed to exist in public and private collections.

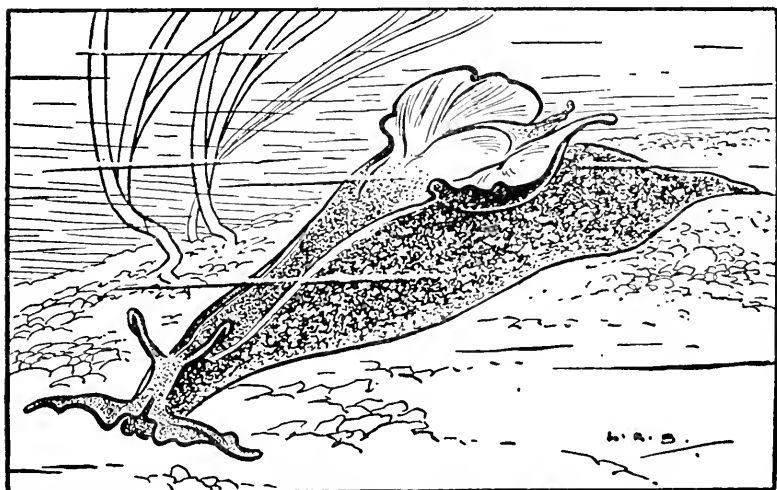
It is related of a famous Dutch collector that being possessed of a particularly fine specimen, he outbid all others at a certain auction in order to obtain yet another Glory of the Sea Cone which was put up for auction. Having at last obtained it, he crushed it underfoot, shouting "Now I possess the only specimen in the country."

Of more interest than this collector's fanaticism is the poisonous apparatus common to the cone family. At least three species are notorious for their bite. The "teeth," arranged in pairs, are exceedingly sharp, and connected with poison ducts which produce painful wounds.

It is interesting to note that the habit which some defenceless creatures have of impersonating and closely resembling justly dreaded species is repeated in certain molluscs. A quite harmless Fountain Shell (*Strombus mauritanus*) almost exactly resembles a highly venomous Cone Shell, haunting the same coral reefs and thus by

“crawling under false colours” avoids the attentions of fishes who have learnt to leave the closely similar Cone severely alone.

The sub-class of the Gastropods known as the *Euthyneura* embraces many strange forms which appear to be midway between the shelled sea snails and the true sea slugs. The sub-class includes many brilliant tropic forms and



Sea Hare (*Aplysia*)

a few common to our own seas, the best known of which is the Sea Hare (*Aplysia punctata*).

This strange mollusc is about nine inches long and with its long tentacles bears a fanciful resemblance to a crouching hare when in a semi-contracted state. It is of a rich velvety brown or purple and may easily be mistaken for a piece of seaweed as it crawls leisurely over some gravel reach. It is a vegetarian feeder, biting off

and swallowing whole large pieces of eel grass, which it grinds up in a powerful gizzard. The gills are protected by a thin horny shell very like a human thumbnail, and this is in turn covered by two flaps of skin. These may be used as wings, the animal clumsily flapping its way through the water. Though eaten by certain fishes, the mollusc can discourage or escape from foes by exuding great quantities of a vivid purple fluid, which, like the ink clouds of the cuttlefish, may obscure the water for several yards around. It further gives out a whiteish fluid of a poisonous nature which was appreciated by the ancient Greeks, who employed it to remove unpopular personages. The animal can give out a powerful cedar oil, which frequent washing scarcely succeeds in eradicating from the hands once they have touched a Sea Hare. The eggs are laid in long threadlike strings amongst weeds and corallines.

The Umbrella Snails (*Umbraculum*) are huge shapeless creatures with a small shell shaped like a Chinese parasol.

The Bubble Shells (*Bulla*, *Acton* and *Scaphander*) are allied to the Sea Hares, but the animals are contained in large globulous shells of beautiful form and colour. *Scaphander lignarius*—the Boat Shell, of our southern coasts—burrows in sand, where it devours bivalves, etc. The food is ground up in a remarkable calcareous gizzard composed of two plates like millstones about the size of a threepenny bit.

Very unlike any of the preceding yet nearly related anatomically are the fairylike Sea Moths or Sea Butterflies, which form dense clouds covering vast areas of the northern seas. The discarded shells of dead specimens sink to

the bottom and form a layer of ooze many feet in depth. These tiny creatures, with fleshy wing-like expanses of the feet and transparent glassy shells, constitute a vital food supply of many whales.

The *Nudibranchs* or Naked Keeled Molluscs, abundant in all seas and at all depths, have parted with every trace of shell, though a distinctly formed spiral shell is nearly always possessed by embryos whilst yet within the egg capsule. The Nudibranchs have much the general appearance of shell-less snails, but the gills and extensions of other organs stand erect and naked in rows upon the creature's back. These often assume most extravagant forms and vivid colours, frequently mimicking the sea anemones, corals, sponges, etc., upon which the creatures feed. A remarkable feature of this diet is that the stinging cells of the sea anemones and the hard spicules of the sponges actually find their way high up into the erect clublike structures of the Nudibranch's back without apparently giving any discomfort. The eggs usually take the form of delicate ribbon-like structures, sometimes arranged on shells, etc., in a neat spiral formation. The larvæ emerge as minute snails, which row themselves through the water by means of two flaps fringed with lashing cilia.

Over a hundred kinds of Sea Slugs are recorded from our shores, the largest, Triton (*Tritonia bombergi*), reaching about nine inches in length. A few species are pelagic, swimming at the sea surface and eating larval fish, jellyfish etc., whilst some deep-sea forms are illuminated with hundreds of light organs.

In the Class *Scaphopoda* are included the Tooth Snails (*Dentalium*) of our shores, which possess white shells like miniature elephant tusks only an inch or so in length. The animal digs itself into the sand by means of a foot protruded from the shell's wide end. Our native species abounds on the northern coast in the sand below three fathoms, where it gathers in large companies, feeding on *Peraminiphera*, a minute bivalve. A large tropical species reaches about six inches in length and has a beautifully-fluted shell of a jade green colour.

The *Lamellibranchia*, or Scale-keeled Molluscs, include the numerous company of bivalves, or shells, which are in two separate but interlocking pieces—common examples being the oyster, cockle, mussel, clam. They abound in every sea and a large number are of the highest economical importance to man.

The typical bivalve has the shells united by a complex interlocking hinge and tough ligament. The shells are further held together on the inside by a stout "adductor" muscle, either end being attached to one of the valves, and which by contracting or expanding causes the two shells to open or shut. The animal has the gills arranged in a series of plates or leaves and possesses two syphon pipes—the one an inhalent, the other an exhalent, by means of which food is drawn into the shell and waste matter afterwards expelled. There is frequently a fleshy foot, which can be employed for creeping, leaping or climbing and it also not infrequently weaves a tough fibrous bunch of threads employed to anchor the shell securely to some solid substance.

Bivalves are usually divided into four main groups,

according to the arrangement of the gills, the orders being known as *Protobranchia*, *Filibranchia*, *Eulamellibranchia* and *Septibranchia*.

The *Protobranchia* include only a few forms, the best known being the little Nut Shell (*Nucula*). Several species of these neat little shells are abundant on our sandy shores, where they often literally swarm and form an important item in the menu of many fishes. The animal has a deeply-toothed fringe to its foot, giving a firm grip amongst grit or gravel and dragging the shell about at a fair speed.

The *Filibranchia* include many valuable molluscs used both for food, ornament and in one instance for clothing. The Saddle Oysters (*Anomia*), often used for inlay work, are common in most seas and are of the beautiful mother of pearl consistency. The shells are invariably attached to some solid object by a thick shelly plug or rivet, which passes through a hole in the lower valve. The shells of some of our own species are so transparent that they are used for glazing windows. The plug apparently corrodes surfaces to which it is attached, so that the shell often lies sunk into a little pit of its own making.

The Arc Shells (*Arca*) abound everywhere, one common species, *A. lacta*, forms the bulk of the famous shell beach at Herm in the Channel Islands. The animal anchors itself by clumps of short horny threads.

The Edible Mussel (*Mytilus edulis*) is typical of its group, and has for long been much appreciated as an article of food. Its edible virtues were not apparently recognised prior to the year 1235, when a shipwrecked Irish sailor,

Walton, discovered its value by mere chance. Being cast away on the shores of a muddy bay off the coast of Western France, he sought about making crude nets to trap sea birds, fixing his nets with stakes driven into the sand. The nets were usually covered at high water, and in time he observed that myriads of small shells attached themselves to the nets. Before long the shells reached a noticeable size, and Walton, discovering the excellence of their contents, took to cultivating them in this fashion when he was finally repatriated. In this manner sprang up a vast industry which is now widely carried on both sides of the Atlantic. Of late years these shellfish are placed in special purifying tanks prior to marketing, for the better assurance of their being free from detrimental germs. The Common Mussel is the chosen host of the Pea Crab noticed in a previous chapter.

It should be mentioned that all bivalves commence life as minute larvæ, hatching from eggs. The larva has minute shells and between them a pair of flaps armed with lashing hairs, which propel the little creature through the water and also carry food into its interior. In time it sinks to the sea-bed and takes to a crawling or sedentary existence.

The Date Mussels (*Lithodomus*), though not unlike Common Mussels, do not anchor themselves by means of a tuft of threads, but tunnel into solid rock, usually limestone, by means of a specially secreted acid. The covering of horny material protects the Date Mussel's delicate shell from its own corrosive secretions. Tourists in Italy are shown a Temple of Ceraphis, the pillars of which are riddled with these mussels, clear evidence that the

surrounding land must have at one time sunk below sea level and later risen again.

The Pearl-wing and Hammer Oysters are nearly allied forms mostly from tropic seas. Of the Pearl Oyster much has already been written. All shelled molluscs, even whelks, are capable of providing pearls of a kind, the pearl being merely a foreign body which has become coated over with layers of the material with which the shell happens to be lined. The true Pearl Oysters (*Margaritifera*) abound off the coasts of India, Ceylon and North-West Australia. The Ceylon Pearl Fishery alone entails the gathering of some 80 million shells per annum, the animals being obtained by native divers or the dredge. Oriental pearls, the most valuable, are often caused by a parasitic worm that finds its way into the tissues of the animal, whilst the seed or mussel pearl is generally formed round small particles of nacre which serve as a nucleus. The Japanese "culture pearls," produced in such abundance of late years, are encouraged by providing the animal with a nucleus in the shape of a scrap of nacre wrapped in a piece of tissue taken from another oyster. "Blister" pearls, which have no commercial value, are formed on the inner wall of the shell itself. Small fish and crabs are sometimes incarcerated within them. In Asia they often introduce small metal images of Buddha, which in time become covered with mother of pearl.

The Thorny Oysters (*Spondylus*) are amongst the most beautiful of all bivalve shells. The massive valves are joined by such firmly interlocking teeth that only great force can sever them, whilst the outer walls bear a forest of long spines often richly coloured and grace-

fully sculptured. The various species abound on coral reefs.

The Scallops (*Pectens*) are nearly related and where found are prized for their decorative and edible qualities. Whereas large specimens are usually sedentary, the smaller kinds are very active, floating through the water in boomerang-like curves by rapidly opening and shutting their valves. The animals are very readily aware of their arch-enemy the Starfish, apparently sensing approaching danger by sight, for the fringe of the animal's outer body wall, or mantle, bears a row of eyes which show a surprisingly high degree of development.

The *Eulamellibranchia* include what perhaps is the most important of all shellfish, the Edible Oyster. The Common Oyster (*Ostrea edulis*) has played a part in popular literature, and one can only regret the vanished days of Dickens's time when the prince of shellfish was purchasable at 3d. a dozen. Oysters are hatched from minute eggs, and discharged in the form of spat as free-swimming larvæ which make their way to the sea surface and there live till their shells are fully formed. They then sink to the sea-bed and become attached to some stable object by the lower or deeper shell. The providing of suitable anchorage, technically known as "culching," is an important part of oyster farming. Although a single oyster may discharge itself of several million young a very small percentage survive the carnage of the surface water, and even when settled for life upon the sea-bed the animal is beset by hosts of enemies. Whelks and the Boring Sponge tunnel its shell, the Slipper Limpet smothers it, crabs heap silt upon it, whilst Starfish, Octopuses or Wolf Fish devour it

whole or piecemeal. An Oyster reaches edible size in about four years.

Early travellers often brought back wonderful stories of oysters growing upon trees, and this observation has proved not so impossible as might at first appear. In tropic seas mangrove roots and overhanging branches which are submerged at high water often acquire a dense covering of oysters, which, when the tide retires, may be left many feet above water level, smothering the trees with dense layers of their shells.

Nearly related, though bearing little superficial resemblance to the Oysters, are the Fan Mussels (*Pinna*). These shells are acutely triangular and of thin horny texture and may reach several feet in length. They are remarkable for the profuse and silky nature of the anchor-threads, which have been employed in the weaving of various small articles of clothing. *Pinna*, as well as the Oyster, are often hosts of the Pea Crab.

The Cockles (*Cardium*), like the Oyster, have a world-wide distribution and may at once be recognized by their globular form and strange ribbed shells. The animal has a very strong muscular foot several inches in length and with it can perform surprising leaps, often covering several yards at a bound. Cockles are essentially sand burrowers, their syphons reaching up to the pure water when submerged.

In a number of allied families popularly known by the all-embracing title of "Clams," the syphons may reach a prodigious length and are often united in a leathery protective covering. The true Clams are massively shelled molluscs of tropic and semi-tropic seas, where they

become embedded in coral formations often so completely that only the outer margin of the shell protrudes.

To this order belongs the largest shell mollusc, the Giant Clam (*Tridacna gigas*) of the Barrier Reef, which may attain a length of four or five feet and a weight of a thousand pounds.

When a large specimen is at rest with its shells agape at low tide it forms a very effective man-trap and gruesome stories of persons thus seized and held by the ankle are only too well founded.

In Australia the shells are used by the natives as foot-baths and to gather rain water.

A remarkable relation of the Clams is the Razor Shell (*Solen*) of our coasts. By means of a muscular foot the animal burrows vertically at a great rate and is often used for food or bait.

The Piddocks (*Pholas*) have thin sculptured shells reinforced over the hinge with several extra plates. Though so frail these shells easily tunnel the hardest limestone until they lie entirely concealed. The animal by means of its powerful feet creates a rowing motion, which causes the numerous fine teeth and sharply-edged facets of the shell to act as a file, whilst an acid secretion may also be brought into play.

The allied Rock Borers (*Saxicava*) drive straight burrows, and should a fellow mollusc lie across their path it is unhesitatingly sacrificed in the steady onward movement.

The Ship Worms (*Teredo*) are borers of historic interest since in the days of wooden ships they helped to sink more vessels than did storms at sea or enemy cannons. The ancients so well knew the devastating effects of these

molluscs that they covered their handsomely carved galleons with sheet copper. Drake's famous ship the Golden Hind largely met her ultimate end through the efforts of this seemingly helpless mollusc. Though at first glance *Teredo* has all the appearance of the marine worm-tube, sometimes reaching many feet in length, the tube is merely an adjunct to the shell proper, a duct giving free access to the sea—a long distance perhaps from the animal as it lies buried deep within a jetty pile. As soon as the free-swimming larval Ship Worm has acquired its two valved shell it attaches itself by a thread to some timber and then, using its shell as a file, proceeds to advance into the woodwork, lining the burrow behind it with a tube of shelly material as it goes.

A strange variant of this tube is seen in the Watering-pot Shell (*Brechites*). This mollusc of the Indo-Pacific Seas makes a long wide tube, one end being closed with a perforated lid, like the rose of a garden can, close to which lies the two small valves enclosing the animal. These strange shells may reach some feet in length and are found buried in sand with the "rose" directed upwards.

The *Septibranchia* are a small group of marine bivalves having the gills modified into muscular partitions dividing the mantle chamber into two portions. Only a few species are represented round our shores, one of the better known being the Sky-gaper (*Poromya*), a small fragile shell with slightly unequal valves and a long transparent foot.

No group of molluscs has attracted such wide attention or is so little understood by the general public as the *Cephalopods*—the Octopuses, Squids, Cuttlefish, etc. They

abound in all seas, and, whilst some are valued for food, the group generally is regarded with repugnance. These molluscs date back to the remote geologic past when the sea swarmed with many forms long since extinct.

In general structure a Cephalopod mollusc is much more highly organized than any of the preceding groups. The body is baglike and may be reinforced by an exterior or internal shell. The head is usually marked off by a distinct neck and bears a pair of large well-formed eyes and a brain enclosed in a cartilaginous case. A horny beak made in two pieces is present and is superficially very like a parrot's. These animals' chief claim to distinction, however, is the foot, which is split into eight or ten arms studded with one or two rows of circular suckers. The arms encircle the mouth and when ten arms are present the two longest are coiled away into pouches one on either side of the head, ready to be shot forward for seizing prey as required.

All Cephalopods are active and carnivorous, and though often aggressive, their soft bodies render them very vulnerable and they must resort largely to concealment or swift retreat for safety. In all species the skin is lavishly endowed with pigment cells of various tints and these being contracted or dilated at will, provide a constant succession of colours, which often exactly harmonise with the animal's surroundings. In addition, all can secrete large quantities of a dark inky fluid or sepia, which is stored in a special sac as required, and shot out through the syphon when occasion rises, obscuring the water for some distance round and effectually covering the creature's retreat.

The body is enclosed like that of a snail in a loose skinny sac—the mantle—whilst from its lower margin underneath the head protrudes a syphon pipe which can exhale the sea-water vital to its existence, and which is passed in an unending stream over the gills. By “breathing hurriedly” the outrush of water can send the animal travelling backwards at a high speed; whilst when occasion arises it may also be used to pump water over the egg capsules or to hollow out a depression in the sand.

Reproduction is effected in a most remarkable manner. The male element in most species becomes segregated in a special extension of one tentacle, and this, becoming detached, leads an independent existence until a female is found. This organ was at first mistaken for a new species of animal and was by some early naturalists even described as a worm. The Cephalopods all lay eggs enclosed in membraneous capsules, usually anchored to weeds or rock. They are incubated by the female, who blows water over them until the young—miniature reproductions of their parents—emerge.

In many deep-sea species light organs are present, whilst the ink or sepia, which as such would be valueless where all is already dark, takes the form of a luminous fluid, which when discharged effectually baffles pursuers.

Highly constituted as they are, Cephalopods show a remarkable degree of intelligence at times. Many kinds are gregarious, whilst others unite to form schools during the migratory periods.

The class is divided into two orders: the *Tetrabranchia*—including numerous species of extinct Ammonites, and the living Nautilus—distinguished by having two pairs of

gills, and the *Dibranchia*, having but one pair of gills and embracing all the other species—Octopuses, Squids, Cuttlefish and Argonaut.

The *Tetrabranchia* are to-day represented by only four closely related species of Nautilus, all from the Indo-Pacific. The animals are of interest since they are the sole survivors of a race that once swarmed in all salt waters and are now known only by their fossilised shells.

It is now generally agreed that all Cephalopods were originally shell-bearing molluscs, the shell as seen in the Octopus and Cuttlefish having become overgrown by the animal's body wall or reduced to a mere vestige. The earliest Cephalopods lived in small conical shells, and as the animal grew, it shut off behind it that portion of the shell which it no longer needed for retreat. Thus the shell became eventually divided into a series of chambers, which, judging by the living Nautilus, were filled with gas to give it buoyancy. Some of these early conical shells reached a length of 15 feet. In later forms they were coiled, at first loosely, later tightly, into a spiral form, more convenient no doubt for rapid transit. The tightly-coiled forms survived much longer than those with the cumbrous conical shells. Familiar to many are the immense Ammonite Beds of the West Country, which in some parts are literally solid with shells, many of which reach two feet or more in diameter.

The shells of the living Ammonite or Nautilus are common enough as ornaments or museum exhibits, but few have seen the living animal. The animal is abundant in the Southern Philippines, where it is a common by-product of the fishermen's traps and is prized as food by the natives.

It is common down to a depth of 300 fathoms and is gregarious, moving about in areas where shrimps abound.

Normally it crawls by means of its tentacles, and these vary in number according to sex and comprise a score or more pairs, each tentacle being without suckers and enclosed in a sheath. The animal is striped or mottled, and this uniform, together with the zebra-markings of the shell, make it very inconspicuous, particularly when seen against a ripply-marked bed of sand.

In an adult of the largest species the shell is divided into some thirty odd chambers, filled largely with a nitrogenous gas. Despite this buoyancy, the animal lives chiefly on the sea-bed, and the mouth of the shell is closed by two large, flattened, tentacled sheaths, which unite to form a sort of lid or operculum.

Apart from the Nautilus's very restricted use as food, the shell is used in the manufacture of pearl buttons. Very little is known as to the reproduction of the animal. The eggs are relatively large, enclosed in elaborate capsules, and are deposited in rows.

The *Dibranchia* contains the giants and dwarfs of the race, its representatives being found in every sea and at all depths. It is divided into numerous families, genera and species.

The strange little animal called *Spirula* has, like the Nautilus, a chambered shell, but this is almost wholly covered by the mantle and is small in proportion to its make-up. Practically nothing is known of the animal's habits, specimens being exceedingly rare. Its shells,

on the other hand, are washed up in immense numbers upon all tropic and sub-tropic beaches.

The Cephalopods known as Squids are, broadly, different from Cuttlefish in having the internal shell composed of translucent horny material, whilst in the latter it is of a limey and calcareous nature. All Squids have ten arms, eight being of more or less equal length, whilst the two long arms may exceed many times the total length of the entire animal, and have suckers arranged on clublike extensions of the tips.

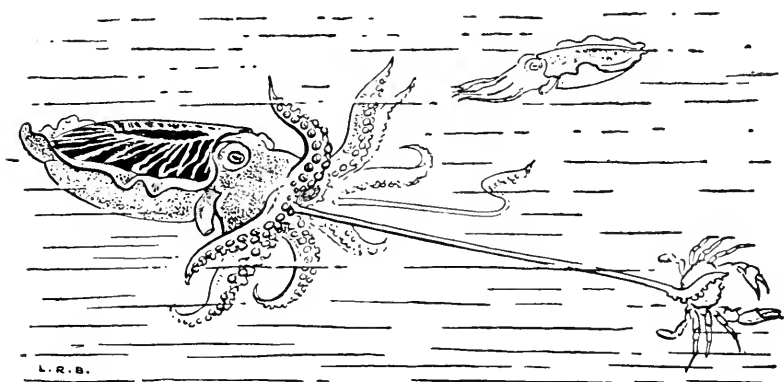
The short arms bear two rows of suckers throughout their entire length. Each sucker is mounted on a short stalk and has its outer rim strengthened by a horny substance, which in many species is composed of numerous stout hooks ensuring a tenacious hold upon anything it touches. The horny beak is similar in construction throughout the group ; whilst the eyes have large and solid crystalline lenses.

Both Squids and Cuttlefish are of some economic value. Vast numbers are used as food and bait, and in the former capacity have masqueraded as tinned lobster. The eye-lenses have been used in ornaments, the ancient Egyptians employing them as eyes for their mummies. Large numbers of Squids are eaten by certain whales and the cetaceans' digestive fluids convert the horny beaks into the valuable ambergris to be mentioned more fully in the chapter on mammals. The limey shell of the Common Cuttlefish (*Sepia officinalis*) is often given to cage-birds, and also forms the basis of many powders used in pharmacy.

Finally, the ink has been almost universally employed for writing and painting, immense numbers of dried ink

bladders being still imported annually to this country from Italy.

Squids and Cuttlefish are highly predaceous, the former living largely upon fish, the latter preferring crustaceans. They swim backwards by ejecting water from the syphon, but can also paddle forwards by undulating movements of their side fins. They are largely gregarious, often congregating in immense shoals which manœuvre with



Cuttlefish (*Sepia*)

almost military uniformity. Whilst the backward darting "flight" can be maintained at high speed for a long time, it not infrequently causes the animal's undoing, resulting in its being cast helplessly ashore.

An astonishing variety of changes have been rung upon the accepted Squid pattern as the result of varying environment and adaptation to special needs. The long arms may be ten times the length of the animal, or the webs uniting the bases of the short arms may be extended to

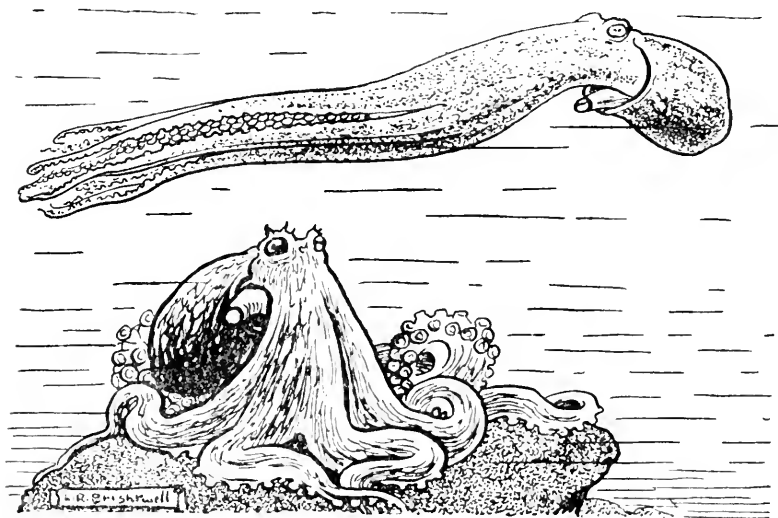
their tips. In some deep sea species the eyes are mounted upon stalks, whilst one common abyssal form bears red, blue and white luminous organs. As already stated, the ink of abyssal species takes the form of highly luminescent fluid.

To the order of Squids belongs the largest of living invertebrates, *Archituthis princeps*, which may have a body length of ten feet and a girth of eight feet, with arms thirty or more feet long. The short arms of such a monster are as thick as a man's thigh, with suckers as big as tea-saucers. Such creatures have inspired many a gruesome tale, amply founded upon fact no doubt, although these deep sea monsters are seldom seen. They are occasionally washed ashore, chiefly on the coasts of Newfoundland and North-West Ireland. The Giant Squid has probably inspired many a sea-serpent story, and is the original of the Norseman's legendary "Kracken" that dragged small fishing vessels to their doom. In a church on the French coast is a stained glass window commemorating a boat crew's miraculous escape from such a disaster. In spite of their large size and ferocity these Giant Squids easily succumb to the heavily-toothed jaws of the Sperm Whale, whose skin often bears marks of the giant Cephalopod's suckers.

The Octopus, beloved of the sensational story-writer and news paragraphist, is at once distinguished from the preceding by having only eight arms of about equal length and horizontal instead of rounded eye pupils. The body is globular in shape and the internal shell has been reduced to two small stylets. In the majority of the species there are two rows of suckers upon each arm, with a total

complement of some two thousand four hundred suckers per animal.

The largest examples come from Australian waters, the giant *Polypus punctatus* having a span of some forty feet. The majority, however, are much smaller, the Common



Common Octopus (*Polypus*)

Octopus, a summer visitor to our shores, rarely exceeding 8 ft. across the outspread tentacles.

Even to-day with a wealth of accurate popular natural history always available, the Octopuses are persistently misrepresented and any extravagant invention finds ready acceptance. That there may be some danger incurred by bathers coming in contact with large specimens is possible, but the danger is largely due to psychological

causes brought about by the animal's uncanny appearance and clammy touch.

Vast numbers are captured in most seas for use as human food, the flesh being firm and not unlike lobster.

In life the Octopus is a creature of infinite resource and tireless energy. It subsists almost wholly upon crabs and lobsters, which it captures with much guile. Unlike the Squid, it does not bite its prey with its beak, but disarticulates the body, extracting the flesh by the use of the whip-lash tips of its tentacles. The Common Octopus has been accredited with deliberately using a dead fish to attract crabs within reach, and if offered oysters beyond its opening powers will refuse these if again offered them.

It can swim backwards like a Squid or stride spider-like over the sea-bed, and at all times changes colour to harmonise with its surroundings. It is subject to seasonal migrations, and the Common species often heads south in autumn, wintering in sub-tropic waters. The female lays her eggs in bunches attached to a rock base, blowing water over them with her syphon until the young emerge. The Octopus is much more spare of its ink than the Cuttlefish and seldom employs its beak for defensive purposes.

The Musk Octopus (*Moschites cirrosa*) is distinguished by having one row of suckers only on each tentacle and enjoys a more northern range than the common species.

The Argonaut of the Atlantic and Pacific Ocean is well known by its beautiful fluted, thin and delicate shell, but the animal is much less familiar. The shell is made only by the female as a receptacle for her eggs and is secreted by a large wing-like expansion of two tentacles,

which inspired the ancients to represent the animal as sailing before the wind with these peculiar arms upraised to catch a favourable breeze. The male, only about one-tenth the size of his consort, is not more than an inch in length. The male element is generated in a sac-like development of one tentacle, which is cast off and adheres to the mantle cavity of the female. The male at no time develops a shell and the female is seen only at the surface when incubating the eggs, retiring to the depths as soon as family duties are concluded.

CHAPTER VII

TUNICATES OR ASCIDIANS AND LANCELETS

THROUGHOUT this work attention has been directed to the various "links," creatures which, while inadmissible to any of the well-defined groups, combine the characteristics of several and point to a systematic development of life in an ever ascending scale. To the casual observer the gulf between the invertebrates—the creatures just reviewed—and the back-boned creatures such as the fish, birds or man, is altogether unbridgable. But throughout the seas at all depths and in every conceivable situation there abound a race of animals which combine the characteristics of invertebrates and vertebrates in an astonishing manner. The members of this group—the Ascidians—suggest little of an animal nature. Many are firmly encrusted or shapeless masses of flesh, whilst some resemble plants. Yet all have certain characters in common and pass through the same strange metamorphosis before reaching the adult and usually sedentary stage.

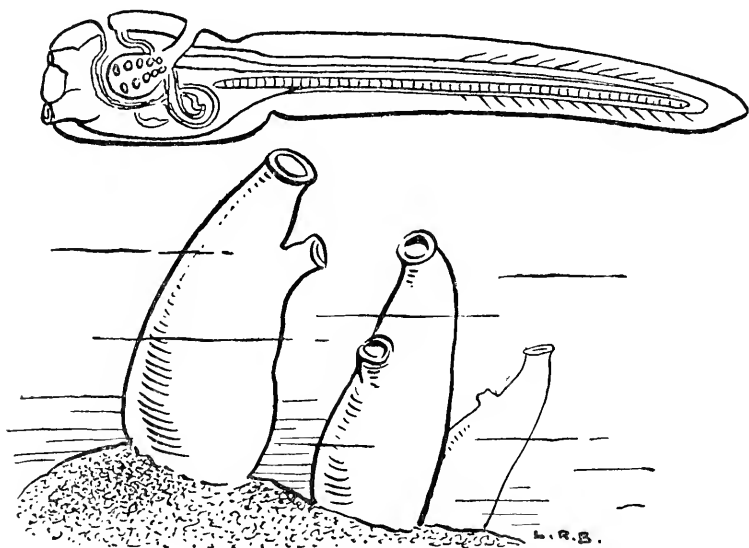
One character apparent in them all is an outer envelope or tubing, which gives the group one of its names, whilst the ever popular title of Sea Squirt is derived from the creatures shrinking when touched and ejecting the sea

water with which they are distended through an opening by a sudden muscular contraction.

If a specimen of the large Flask Ascidian (*Ciona*) be examined, it will soon be apparent that the animal has little in common with a sponge, sea anemone or mollusc. The inner body wall is pierced with innumerable slits that form a sieve which serves not only for the purpose of respiration, but as a strainer that catches the minute organisms upon which the Ascidian feeds. Water is continually taken in through one funnel-like opening and, when robbed of its food content and oxygen, is ejected through another close beside it.

The creature has a well-defined heart, liver, stomach and intestine. How nearly akin to higher animals these inert creatures actually are, however, was not suspected until a minute tadpole-like animal was discovered to be the larva of this living sac. This larva in many ways offers a striking parallel to the tadpole form of frogs and newts. It has a definite eye, brain, ear and mouth, digestive track, heart, a nervous system, and above all a notochord, similar to that formed in the development of every backboned animal. For a period, varying according to the species, the larva, hatched from an egg, leads a free and independent life, swimming vigorously by means of a long tail fin. There comes, however, a time when it attaches itself to some object—weed, rock or harbour pile, and then undergoes a strange course of degeneration, forfeiting its notochord, tail, part of its nervous system, and indeed everything save the few organs essential to existence. The final form may vary to an extraordinary degree, both in shape and ways of life.

A few outstanding types only can be enumerated since our own southern shores alone can show over fifty species—a minute fraction of the Ascidian population of the seas. Though so diverse in shape, all feed in the same manner, namely by sweeping food towards the interior by a series of lashing hairs. All are hermaphrodite and



Tube Sea-Squirt (*Ciona*). Above : Larval stage (enlarged)

reproduction is effected through the medium of eggs and budding.

The Tube or Flask Sea Squirt (*Ciona*) is a big vase-shaped form often seen depending from the walls of caves or covering the sea-shore structures. Being often encrusted with debris, it is not attractive in appearance, but in Southern Europe is regarded as a *bonne bouche* and eaten raw under the euphonious title of *Violette de mer*.

An allied Ascidian, *Ascidiella*, is abundant on muddy bottoms, where it forms large masses suggesting plant tubers. Another group forms huge leathery patches and are of a vivid colour. One such, *Leptoclinum*, is abundant in certain caves in the Channel Islands, and Victor Hugo in his "Toilers of the Sea" refers to it in the passage, "the walls are splashed with crimson stain as if giants had been fighting there."

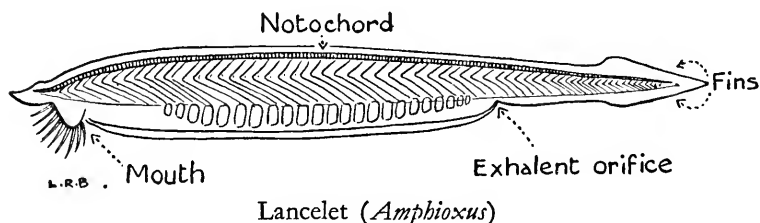
A number of common and beautiful species are included in the genus *Botryllus*, one—Golden Stars—often covering stones and weed plants with richly tinted shapeless masses, made dazzling by a pattern of golden stars that stand out in vivid relief against a background of reddish brown or deep jade green. *Botryllus* is one of the very numerous "compound" Ascidians, in which the individuals are joined one to the other, forming masses of varying form and extent.

Yet another group of Tunicates leads a free floating life in the open sea, one of the commonest being the translucent *Salpa*. This demonstrates "alternation of generations." A solitary *Salpa* being hatched from an egg produces a chain of buds often breeding hundreds and reaching a considerable length. The buds in turn set free groups, each bud containing one egg, and so the series—chain *Salpa*, solitary *Salpa*, chain *Salpa*, and so on—goes on indefinitely.

A remarkable species of Ascidian, *Oikopleura*—the Housebuilder—retains the larval tail throughout life, swimming powerfully and continually investing itself with, and discarding, a large gelatinous structure many times its own size and entirely covering the body.

Why the Ascidians, having travelled so far upon the road of evolution, should cease to progress and degenerate is at present one of the many unsolved problems of the biologist. Even their origin is pure conjecture, since fossil remains of any soft-body creatures are extremely rare and of these none have anything recognisable as Ascidians have as yet come to light.

Somewhere between the Ascidians and the Fishes may be placed that strange little creature known as the Lancelet or *Amphioxus*. Several species are abundant on sandy



shores in most warm seas, the first Lancelet being recognised by the Cornish naturalist Couch, who discovered our native species on the south-west coast just over a century ago.

As the name *Amphioxus* implies, the creature is pointed at both ends. It is flattened, leaf-like, and glassy, and the largest species attains to only a few inches in length. If compelled to exert itself, it swims feebly for a few feet, then sinks as though exhausted to the bottom, quickly hiding itself in the sand. It comes out chiefly at night, and the sexes though separate are distinguishable only by a microscopic examination.

Amphioxus has a notochord, but no definitely recognisable heart. Water flows in at the cilia-fringed mouth, passes over the sixty pairs of gill slits, and exits by an opening under the undersurface. Like the Sea Squirts, it feeds chiefly on Diatoms and in swimming can reverse as easily as it travels forwards. The minute transparent egg, laid in the late summer, hatches in about eight hours, the young having the mouth sealed up for the first twelve hours or so after hatching. The Lancelet is usually found on a sandy or gravel bottom just beyond low tide limit.

CHAPTER VIII

FISHES

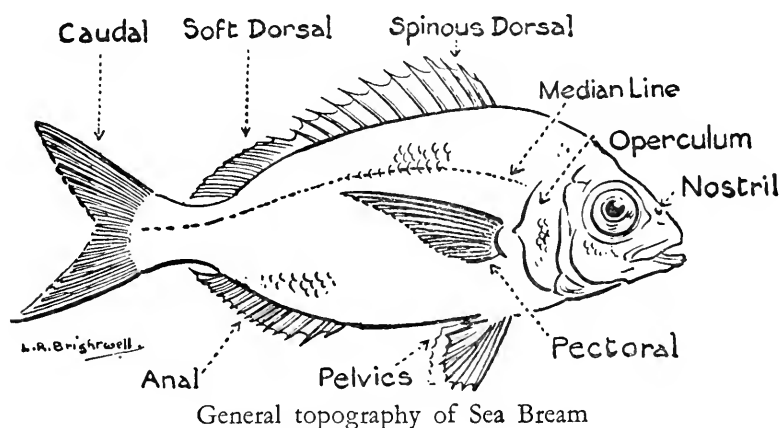
NO branch of the animal kingdom offers a more bewildering range of forms or a greater medley of contrast in its ways of life than does the group of animals collectively spoken of as "fish." Fish are especially adapted for a life in the water, the majority being elongated and "streamline" in form. The surfaces of their bodies, which are usually covered with scales, are thus free from irregularities that might impede progression when swimming.

In most fish the fins, which vary greatly in size and number, are what is termed "paired" and "unpaired," the former corresponding to the limbs of the higher terrestrial animals. The paired fins are represented by the pectoral or breast fins and the pelvic or abdominal fins, the unpaired by the dorsal or back fins, the caudal or tail fin, and the anal fin, which is situated on the under surface of the fish close to the base of the tail.

The pectoral fins, which are usually used for the purposes of steering, may likewise be employed to assist it in various other functions, such as in climbing—as in the case of the Mud Skippers, or even flying—as in the case of the Flying Fish and Gurnards.

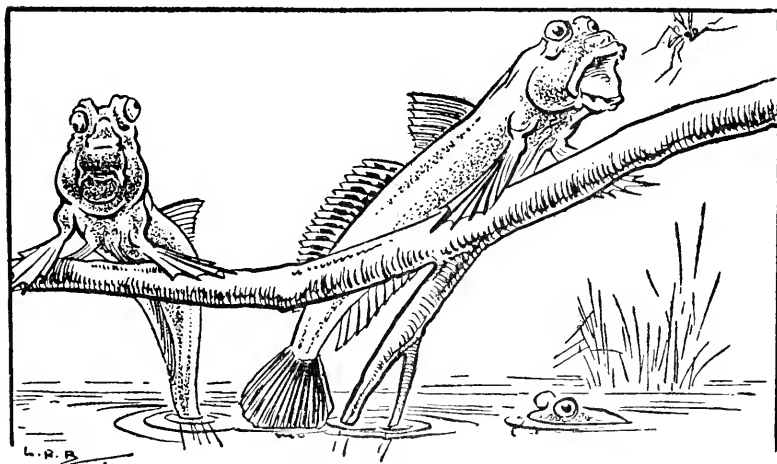
The Mud Skipper (*Periophthalmus*) is a fish living in

brackish water at the muddy mouths of rivers and is by no means incommoded by finding itself on *terra firma*. It inhabits tropical Africa and Asia. It seldom measures more than six inches in length, and resembles in general shape our common Goby, to which it is in fact closely related. The hand-shaped pectoral fins are so supple that they have enabled their owner to virtually conquer the land and by their means the Mud Skipper can scramble



out of the water and even ascend trees. Its enormous bulging eyes are set close together on the top of the head, and these keep a constant look-out for the chance fly, just above the water line. Exposed as it is to the fierce rays of the tropic sun, the eyes might become uncomfortably dry but for the fish's habit of constantly lubricating them by rolling them in their sockets. When chasing flies ashore the Mud Skipper is exposed for long periods to the air, and in order to breathe in this unusual environment the tail, with its rich supply of blood-vessels, serves

as an auxiliary breathing organ. The caudal appendage is in fact frequently allowed to dangle in the water, thus drawing a supply of oxygen whilst the rest of the fish remains high and dry. After a tropic rain Mud Skippers sometimes invade the paddy fields far inland, and when they do so *en masse* during thunderstorms such migrations



Mud Skippers (*Periophthalmus*)

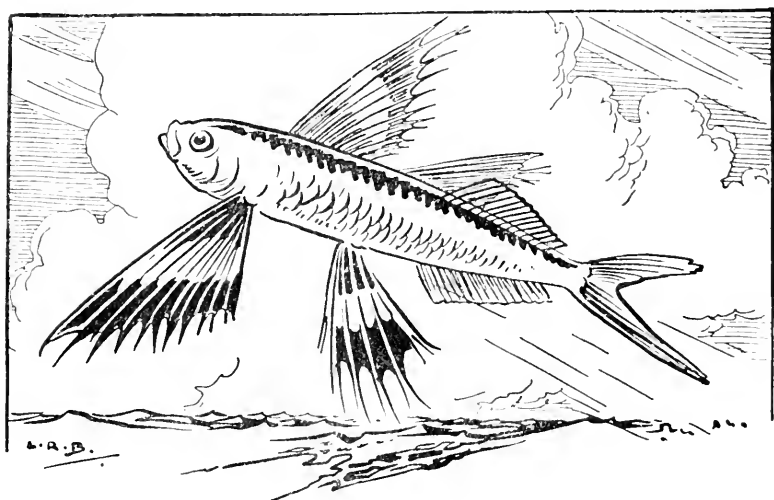
may account for the many stories of showers of fish falling from the sky.

In the Toad Fishes (*Chaunacidae*) and Frog Fishes (*Antennariidae*) the pectoral fins likewise take the form of arms. These have long basal joints ending in "hands" and with these they are able to climb about on sandbanks and coral reefs.

In the Gurnards (*Trigla*) several rays of the pectoral fins are detached from the others and form long "fingers,"

by means of which the fish walk over the sea floor or may even climb rocks.

In the herring-like Flying Fish (*Exocoetidae*) the pectoral fins are transformed into large wings, which may extend backwards as far as the tail and enable the fish to plane through the air. A certain amount of controversy has



Flying Fish

arisen as regards the manner by means of which the fish sustains itself in the air. Some authorities are of the opinion that the wings are merely utilised as gliding planes, whilst others are definitely of opinion that the fish vibrates its fins in the way a bird does with its wings, only much faster. According to J. R. Norman, the prolonged aerial excursions of the Flying Fishes are improvements on the spasmodic jumps of other fishes.

According to this authority the actual flight seems to be carried out as follows :

“ The fish accelerates its speed, rushing along near the surface of the water with its tail moving very rapidly from side to side ; it then makes a sudden leap out of the sea and is borne along through the air with the pectoral fins outstretched and practically motionless. The chief motive power of this soaring flight is supplied by the tail, there being little if any flapping of the wings as in birds or bats. The pectoral fins act merely as parachutes which enable the fish to glide through the air. The flights, sometimes as much as a quarter of a mile in length, take place as a rule quite close to the water, but the fishes may occasionally be carried upwards by air currents to a height of over 20 feet and in this way may land on the decks of ships.” Dr. Hankin, who has made a study of the “ flight ” of these fish, has estimated that under favourable conditions they attain a speed of over fifty miles an hour.

The commonest species of Flying Fish—*Exocoetus volans*—inhabits the Mediterranean Sea, the Indian Ocean and the Australian and Chinese Seas. It is an occasional visitor to our southern coasts and not very many years ago a large shoal made its appearance off Weymouth.

In the Flying Gurnard (*Dactylopterus*) the upper portion of the pectoral is modified to form a wing which enables the fish to plane over the surface of the water. The lower portions function as feet as in other Gurnards. Dr. William Beebe, in his delightful book, “ Beneath Tropic Seas,” writes of this fish : “ As regards the scope of its life activities it is almost in a class by itself, for while angels and bats have conquered only two elements, the Flying

Gurnard is at home not only in the water and air but is able to trot easily about on solid earth bottom. In fact the latter mode of progression seems to be its favourite. I have seen Gurnards rise and scale away from the back of a vessel and I have had a school of half-grown ones slap against the side of a rowing boat. In the young fish the fins are too short for flight, but even a specimen two inches in length will leap out and spread its diminutive wings, only to flop back at once. At best they are less skilful aviators than the true Flying Fish. Gurnards have great muscle velocity and one of these fish has been known to knock a sailor senseless by a head-on blow between the eyes as the man stood at the wheel of a schooner." The latter accident is less surprising than it would at first appear if we bear in mind that the large conical head of a Gurnard is cuirassed with heavy plates.

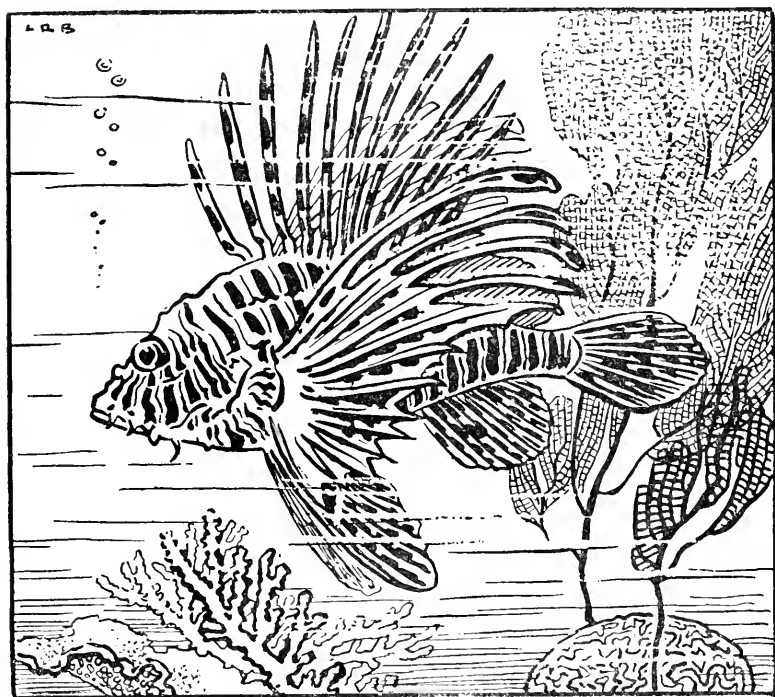
The Sapphirine Gurnard (*Trigla hirundo*), which is common off our coast, is the largest member of its family, attaining a length of two feet and a weight of 4 lbs. The brilliant blue and green tints of its very large wing-shaped pectoral fins resemble the wings of certain dazzling tropical butterflies.

In the carnivorous Dragon or Lion Fish (*Pterois volitans*) of East African and Asiatic coasts the pectorals are enormous and likewise wing-shaped.

The function of the pelvic fins is connected with the maintenance of the fish's equilibrium and may be compared to the centre board of a yacht. The pelvic fins in some cases form sucking discs which enable the fish to adhere to the rocks and stones.

In the Gobies (*Gobioidea*) of our own rocks and pools

the fins are fused to form cup-like suckers, and a similar sucking disc is distinguishable in the large Lump-suckers (*Cyclopterus*). By means of this disc a Lump-sucker may adhere to objects with such power that a pull of many



Dragon Fish

pounds is required to remove it from the object to which it is attached.

In the Sharks and Rays the hinder part of the pelvic fins in the male are transformed to form unique organs known as "claspers," which serve to retain a hold on the female.

The dorsal or back fin shows an infinity of size and design and may be supported by strong spines. In the primitive cartilaginous Sharks they act as balancers, whilst in the more modern bony fishes they may function as swimming, leaping, sensory, offensive or defensive organs. In some fishes this fin may be so shaped as to mimic fronds of weeds, thus aiding in concealing the wearer. It may likewise, as in the case of the Angler Fishes (*Lophiidae*), where the first dorsal-fin ray is placed on the snout, be converted into long "fishing lines."

Angling finds its highest expression amongst a remarkable group of fishes represented in home waters by the Common Angler (*Lophius piscatorius*)—a fish that may attain a weight of over 30 lbs., and a length of 5 feet. It is a fish that combines rod, line, bait and creel in its own person. The rod is always baited and the creel is apparently capable of any expansion. The animal's head is twice the size of a soup plate, with a mouth that threatens to meet behind. In proximity to the minute eyes is an enormous spined fin-ray tipped with a flap which rises and wriggles with the current and serves as a bait or lure. Once a small fish is deceived into attempting to assault the living bait, the rod bends slowly towards the Angler's enormous mouth, which suddenly opens and the prey vanishes for ever with the inrush of water. The mouth is ringed with several rows of hinged teeth, which make escape impossible.

The Angler, being draped with flaps of skin which mimic the surrounding weeds, is so completely one with the seaboard that it is not surprising that it should be mistaken for part of the landscape. Not only is its colour in perfect

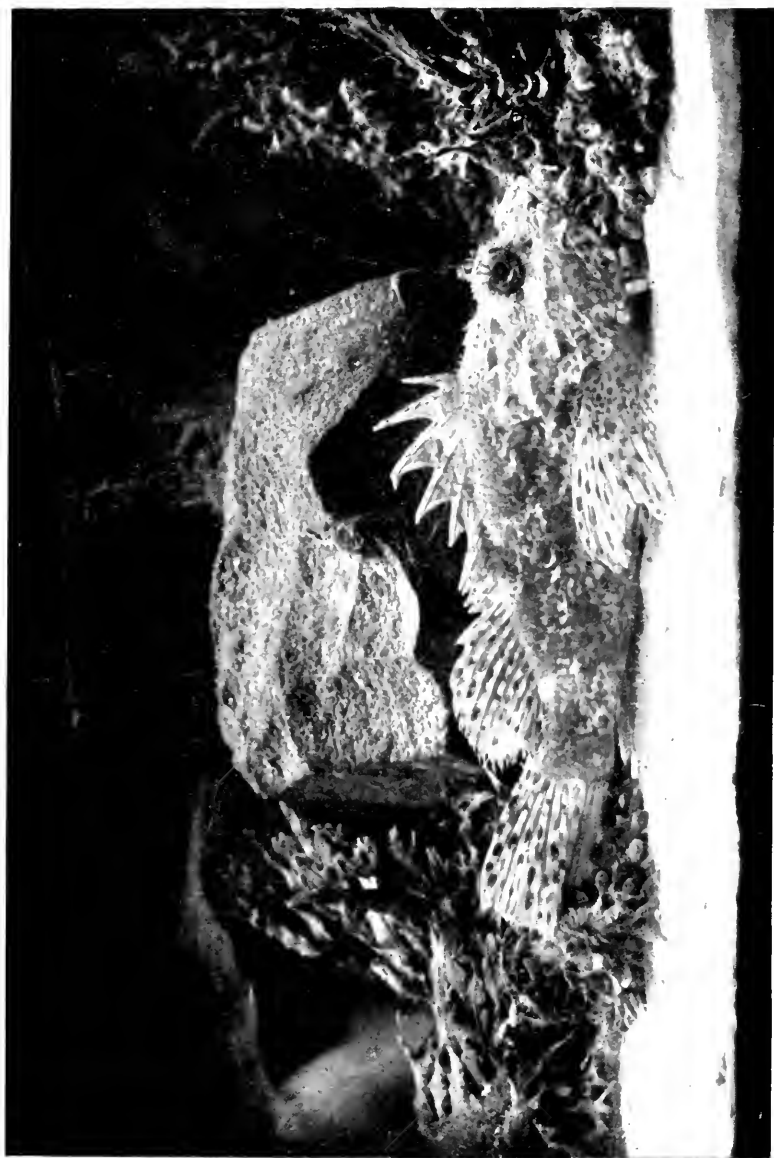
harmony with the rocks and mud upon which it lies, but the "permanent smile" is ringed with innumerable flaps daintily scalloped. Even its eyes are scarcely distinguishable from acorn barnacles or the rayed pattern of certain sea squirts.

Other Anglers adopt slightly different methods, as dictated by their environment. Thus in some the rod and line is exaggerated to form a yard-long whip-lash, whilst in certain deep-sea Anglers the body is illuminated by a phosphorescent organ which, shining in the darkness of the abyss, attracts other fishes to their doom.

In the Dragon Fish, Weevers (*Trachinus*) and Trigger Fishes (*Balistes*), the front dorsal fin may be supplemented with sharp or serrated spines, which are used for offensive or defensive purposes.

In the Weevers, bottom-haunting, sand-loving fish, the spine, situated on the first dorsal fin as well as the one on each side of the gill cover, may be compared with the poison fangs of serpents, being connected with glands which secrete a very poisonous fluid.

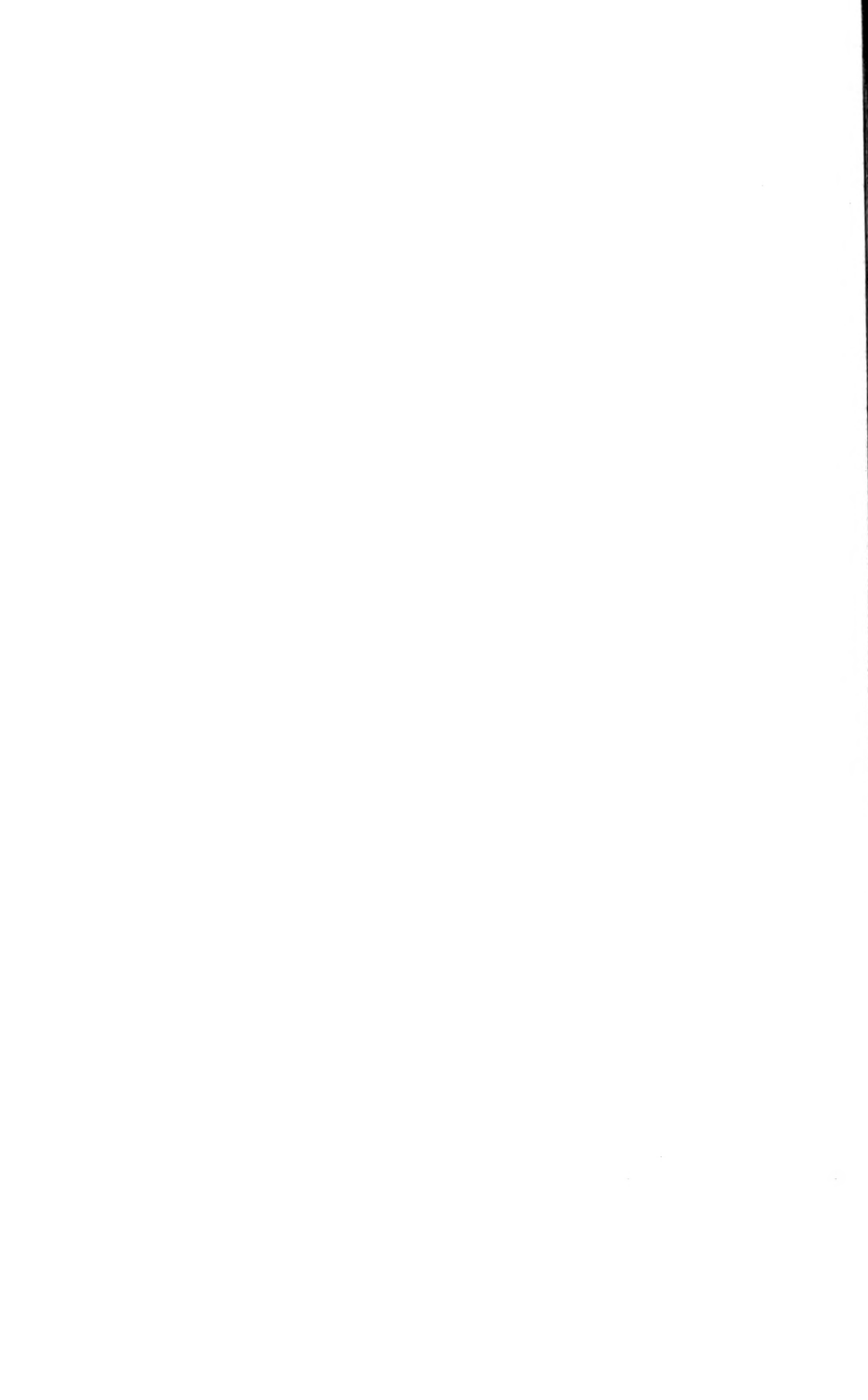
Two species of Weever Fish are known from our shores—the Greater Weever (*T. draco*), which grows to a length of nine inches, and the more common Lesser Weever (*T. vipera*), which seldom exceeds six inches in length, but is more noxious than its larger relative. Both deserve their Old English name, which signifies "viper." Though the wounds these fish inflict are seldom fatal, they may be exceedingly painful and can put the victim out of action for several weeks. Since Weevers habitually lie concealed in sand in shallow water, unshod feet may easily come into contact with them. "Ware Weevers" is a notice dis-



F. W. Bond, photo.

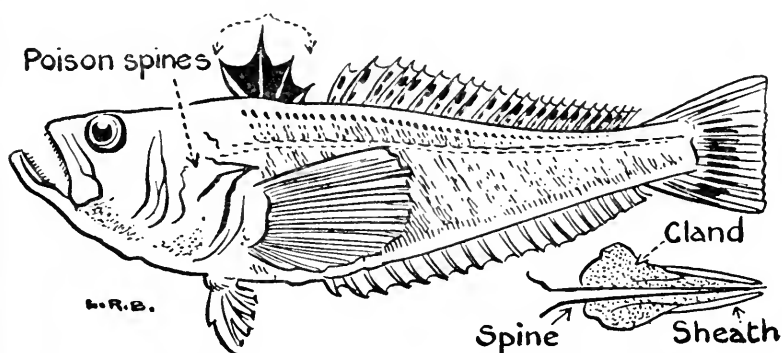
SCORPION FISH

(Facing page 128)



played on some shores and should not be disregarded. The Larger Weever is excellent eating and on the Continent is sold for food, the removal of the spines before being displayed on the market being in some countries enforced by law.

In the Trigger Fishes the dorsal fin is supported in front by two spines, the first one very stout, short and serrated and hollowed out behind in order to receive the knob of the base of the second. This first spine remains



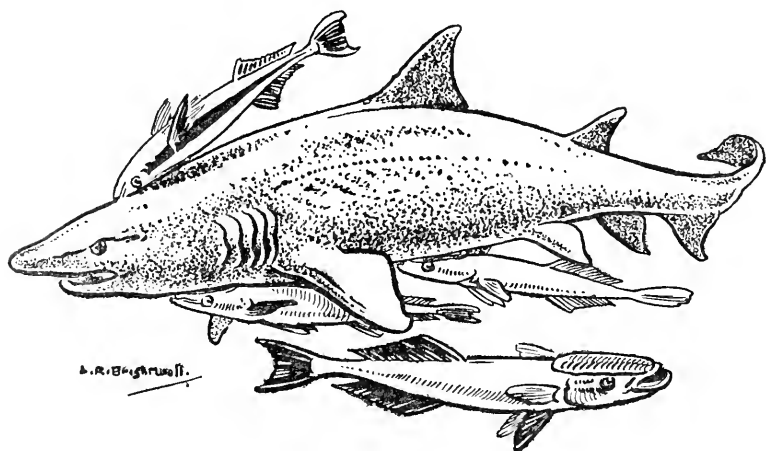
Lesser Weever : and details of poison spine on gill cover

erect until the second is depressed. The "safety catch" is then released and the serrated spine is shot out with great force.

In the Deal Fishes and Oar Fishes (*Trachypteridae*) the dorsal fin extends along the whole upper surface, the rays on the head being prolonged into long filaments, and in the young of the Deal Fishes these filaments may measure more than four times the length of the fish itself. *Regalecus glesne* is the largest species of Oar Fish, attaining a length of nearly 25 feet.

In the Sail Fish (*Istiophorus*)—a fish built on mackerel lines—the dorsal fin is of enormous size and forms a huge sail, which is folded away in a groove when not in use.

In the Shark-suckers or Remoras (*Echeneius*) the first dorsal fin is transformed into an oval sucking disc, the spines forming a double series of transverse plates surrounded by a fleshy fringe, and the erection of the plates results in



Shark-suckers or Remoras

a series of vacuum chambers. By means of this powerful disc the Shark-sucker securely anchors itself to the back, sides or undersurface of a shark, where it batters on such fragments of food as are always in evidence when a shark tears at its prey.

So well known is this fish's curious trait that from early times the Shark-sucker has been utilised by native fishermen to aid them in the chase. One or more are put over the sides with long lines attached to their tails. The

fish quickly secures itself to a shark, sea perch or turtle, when both are easily hauled aboard. Shark-suckers are cosmopolitan, and although quite good swimmers prefer to attach themselves to pelagic fish, turtles and even vessels.

When Christopher Columbus discovered Cuba he made a note of the fact that the *Remora* was employed by the native fishermen and the following account is found in his "Life" by his son Ferdinand: "In one of the channels they espied a canoe of Indian fishermen, who very quietly without the least concern watched the boat which was making towards them, and being come near made a sign to them in it to attend until they had done fishing. Their manner of fishing was so strange and new to our men that they were willing to comply with them. It was thus: they had tied some small fishes they called *Reverso* by the tail which rubbed themselves against other fish and with a certain roughness they have from the head to the middle of the back they stick themselves to the next fish they eat; and so when the Indians perceive it, drawing their line, they land them both in together. And it was a tortoise our men saw so taken by these fishermen, that fish clinging about the neck of it where they generally fasten, being by that means safe from the other fish biting them. And you see them fastened upon vast sharks."

The anal fin, like all other fins, exhibits variations in size and shape. When short it may act as a balancing organ, or when long as an organ of progression. As in the case of the dorsal fin, the first two rays may be spinous and separated from the soft rays.

The tail or caudal fin is the most powerful and active

of all the fins and may be transformed into a long and formidable weapon of offence, as in the case of the Thresher Shark (*Alopias*). This fish swims round and round a shoal of fish whilst lashing the water with its tail, so driving them into a dense mass, when they are easily captured and devoured.

In the Rays and Skates (*Raia*) the tail is long and in some cases whiplike and armoured with a sharp spine serrated on both sides like a double-edged sword. With this weapon the fish is capable of inflicting severe lacerating wounds which are aggravated by a poisonous secretion exuded from the skin. When the spine is worn out it is immediately replaced by a new one. This apache of the sea, which has a very wide distribution, was well known to the ancients, who wrote that the wounds inflicted were beyond the reach of remedy and invariably resulted in the death of the victim. At the same time they asserted that the spine when reduced to powder possessed remarkable healing powers.

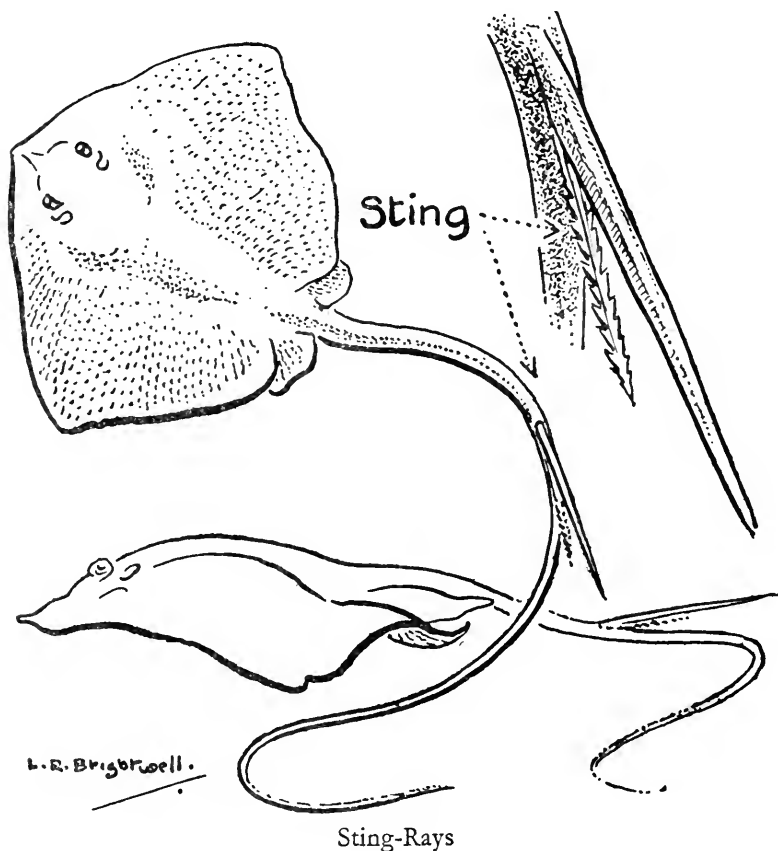
According to J. R. Norman the shape of the tail provides an index of speed and agility, and according to this author fishes with deeply forked tails are capable of swimming for long periods at high speeds, whilst those with square or rounded tails, though capable of sudden bursts of speed, are comparatively slow swimmers.

In the Sea Horse (*Hippocampus*) and certain Eels the caudal fin is absent.

The streamline mackerel shape is obviously the ideal, but there are numerous deviations from this form. Thus in the Rays or Skates (*Raia*) the body is circular and flat from above downwards, and in a few fishes such as the

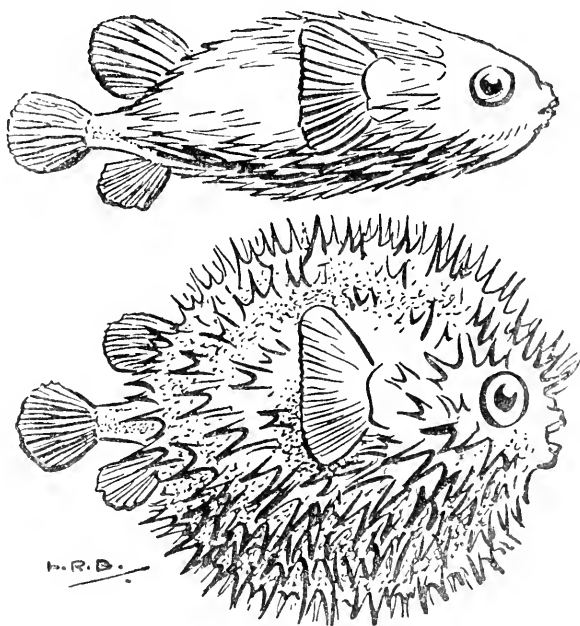


Bat Fishes (*Onchocephalidae*) and Angler Fishes (*Lophiidae*) it is short and thick, whilst it may be very deep and compressed as in the Angel Fishes.



The Flatfishes (Order *Heterosomata*), which live on sandy or muddy bottoms, are characterised by having their bodies flattened from side to side. Since they swim horizontally and not vertically as do other fishes, an equal

development of fins and other organs on each side would be to the animals' disadvantage. As a result, although when first hatched the baby fish looks like any other fish, its sides being symmetrical and equal with an eye upon each side, in the course of a very short time an extraordinary

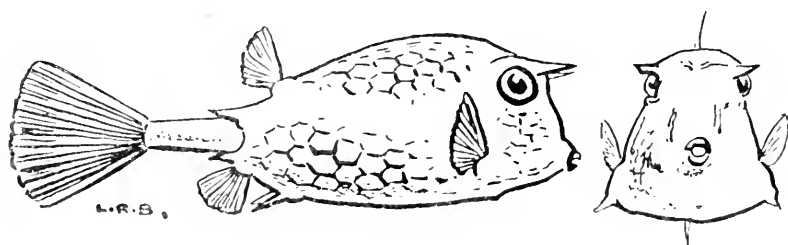


Globe Fish

transformation takes place. After living near the surface for a few weeks feeding on microscopic animals and plants, the body of the infant Flatfish shows a tendency to tilt to one side. The fish as the result of this distressful state of affairs sinks slowly to the floor of the ocean and at the same time the eye situated on the underside gradually

creeps round to meet its fellow. When two months old the fish has sunk to the sea-bed to take up a one-sided view of life, the undersurface of the body being denied light remaining white whilst the reverse side becomes pigmented.

The Globe or Puffer Fishes (*Tetraodon*) have the power of inflating themselves until they become spherical in shape. The skin when blown out becomes distended and stretched tight and the double-rooted erectile spines with which many of these fishes are covered act as for-



Cow Fish

midable weapons of defence and compensate their owner for its indifferent swimming power.

The Trunk and Cow Fishes (*Ostracionidae*) are likewise very slow swimmers, and like the Puffer Fishes rely on their armour. In their structure these fishes recall certain primitive fish of the old Red Sand Stone Period, the body being encased in a perfectly rigid cuirass with the tail similarly armoured and attached by a socket-like arrangement, which permits very little movement, confining its functions purely to that of a rudder. In the case of the Cow Fish the popular title refers to the shape of the head, the bovine appearance of which is accentuated by two prominent hornlike structures one over each eye.

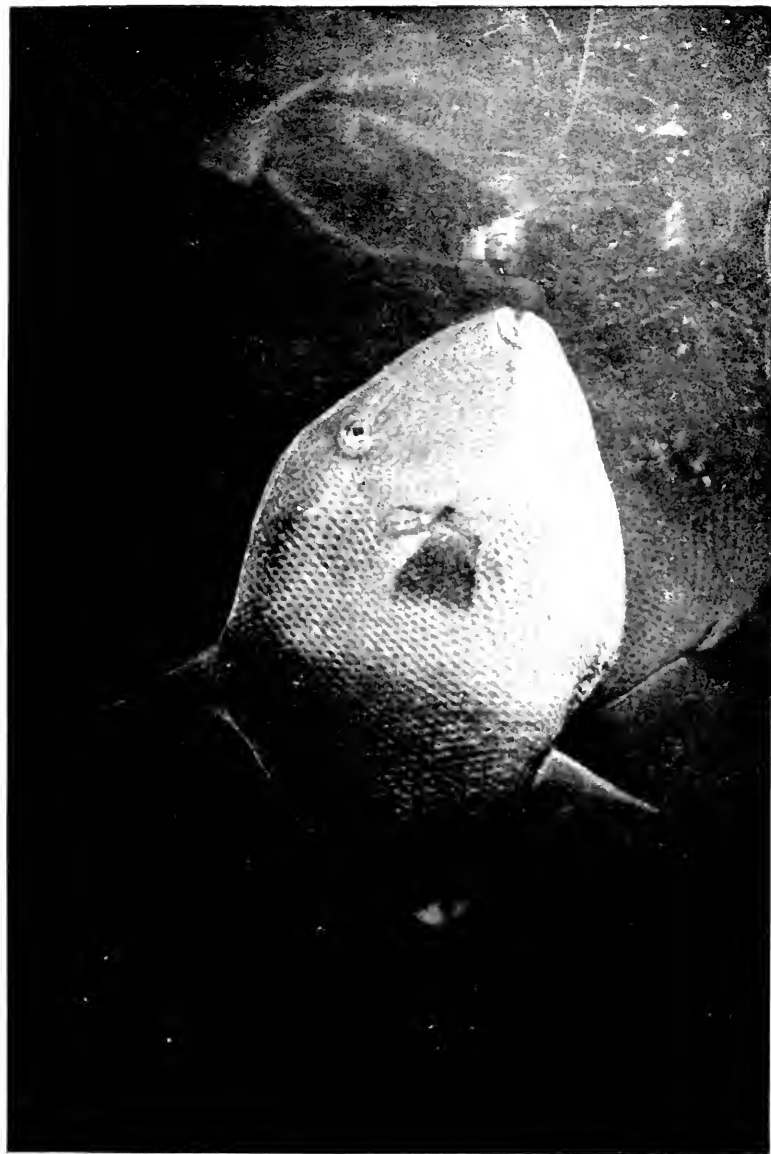
Related to the Puffer Fishes and Trunk Fishes is the deep circular and much compressed Sun Fish or Head Fish (*Mola*). In this fish the leathery body is so abbreviated behind that the impression given is that it has been amputated just behind the dorsal and anal fins, which appear as if attached to the head. Its generic name was given to it by Linnæus, who saw in the fish a resemblance to a mill-wheel. The body of the fish is adapted for drifting, but since certain deep-sea fishes have been found in the interior of captured specimens, Sun Fish in all probability periodically descend to great depth.

In the Sea Horse (*Hippocampus*) the head and body is suggestive of a knight of the chessboard. In these fishes the powerful tail is prehensile and serves as an efficient grappler.

Fishes with elongated bodies are represented by the Eels and Ribbon Fishes.

Whilst the jaws and teeth of many fresh-water fishes reach a high state of development as seen in the Pike and the Brazilian *Pirana*, they show a much greater diversity of form in sea fishes. They are the result of slow evolutionary changes and the first primitive fishes were without jaws in the true sense of the term, possessing merely suctorial orifices similar to those which still obtain with the Hag Fishes (*Myxine*) and Lampreys (*Petromyzon*).

The jaws of fishes are modifications of the branchial arches and reach their highest development in the bony fishes. Since many forms must often seize prey under difficult circumstances, a large extensile mouth offers many advantages, and in some fish the mouth can be shot forward whilst at the same time widening to a remarkable

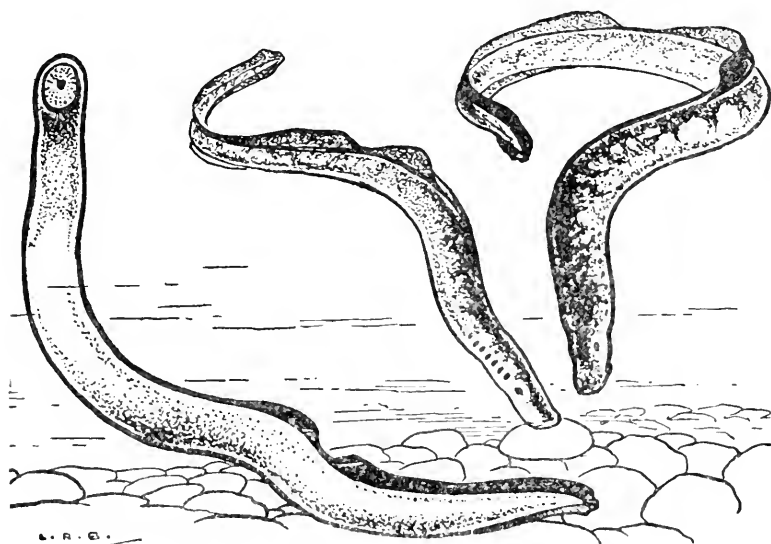


F. W. Bond, photo.

SPOTTED PUFFER FISH

degree. A notable example is that of the John Dory (*Zeus faber*), whose mouth is practically telescopic, shooting forward to grasp prey at a distance with an ease and rapidity recalling the slide of a trombone.

The mouth may be placed centrally in the front of the head, as seen in most fishes, or arranged in a downward-



Lampreys

pointing direction, a device very common in bottom-feeding species such as the Skate (*Raia*), Dogfish (*Scyliorhinus*), Sturgeons (*Acipenser*), etc. The large majority of fish are virtually living trawl or tow nets, engulfing the prey whole and sometimes taking in all kinds of extraneous matters such as stones or weeds in an indiscriminate fashion. Such fish have, as a rule, feeble dentition, teeth

being of little practical value, though in certain abyssal forms (*Choliodus* and *Haplostolea*) they form a veritable *chevaux de frise* barring the escape of any creature once seized, and are of such excessive length that they protrude in both an upward and downward direction when the mouth is closed. In the Common Angler (*Lophius*) a somewhat similar device is present, many of the teeth being hinged so that the prey can slide over them and into the Angler's interior, but cannot hope to retreat over them and into the water beyond. Such fish as the marine Barracuda have razor-edged teeth rivalling those of the Sharks and capable of inflicting lethal wounds upon much larger fish and even human beings.

More discriminating fish often have quite small mouths, those of the Sea Horse (*Hippocampus*) and the Pipe Fish (*Syngnathus*) being typical examples. Here, however, the prey being minute, virtually no teeth are required, in striking contrast to those fishes habitually feeding upon hard substances. The Wrasses (*Labridae*) commonly eat crustaceans, molluscs or acorn barnacles and corals, the two last being nibbled or broken off with a sudden wrench. Such food once seized needs special mastication before it can be digested, and to this end hard enamel, pavement-like teeth are often present on the tongue and roof of the mouth, or even in the throat.

Remarkable is the dentition of the Wolf Blenny or Sea Cat (*Anarhichas*), of our eastern and northern coasts, a fish commonly sold under the name of "Rock Salmon." It habitually eats the spine-covered Stone Crabs, Oysters and giant Cockles, cracking the latter into pieces the size of a half-crown and swallowing them whole.

Though quietness is the first essential of the "gentle art," it is still a matter for debate as to how far fish can be actually said to hear. The ordinary organs of hearing are entirely absent, but experiments have proved that many fish are highly sensitive to vibrations, whether above or below water, and since sound or vibrations travel faster below than above water fish readily detect the slightest disturbance of their element.

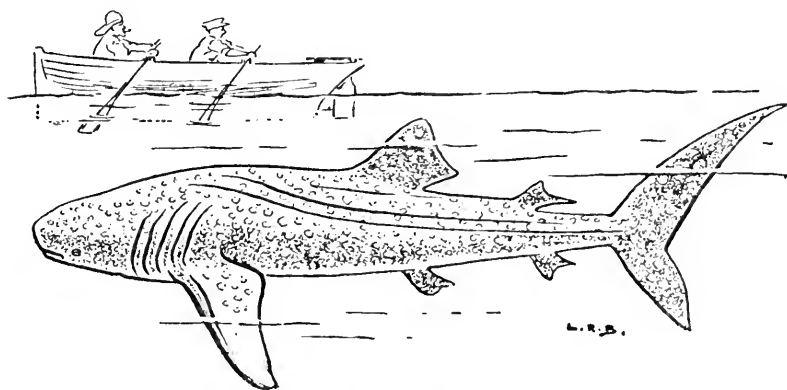
What corresponds to the normal ear in fishes consists of a membraneous sac enclosed in a bony chamber on either side of the back of the head, and each sac contains three canals or chambers containing limey concretions which are imminently sensitive to vibrations and which further aid in maintaining the balance of the fish. The largest of these structures is known as the otolith, and in some fishes, such as the Ling and Bream, attain considerable proportions. An interesting feature common to all otoliths is that they bear numerous concentric rings, each marking the cessation of annual growth, which occurs usually in winter when the fish feeds less. Comparatively recent research has shown these rings correspond to other rings borne upon the scales, the two between them constituting, up to a point, reliable records of the fish's age. When far advanced in years, however, these annular rings are liable to become obliterated and therefore the potential longevity of any given species is largely conjectural. More is known regarding the age of fresh-water fishes than those that inhabit the seas. Domestic Carp are believed to be very long-lived, but according to Dr. Tate Regan, who has made a study of the age of fishes, in the wild state the fish probably does not exceed 15 years. Fish age

records, like most fish stories, are open to doubt, as was evinced by the Pike represented to be 200 years old merely because a Queen Anne coin was found in its interior. Many fish are, however, known to live for more than 60 years. The shortest-lived fish is a Goby (*Latruncbus*), which exists for but a single year.

The air bladder is an all-important organ and like the lungs of higher vertebrates is an outgrowth from the gullet. In most fishes it contains a variety of gases and helps to keep the fish afloat, whilst in some fresh-water forms it may serve the purpose of an auxiliary breathing organ. The air bladder is indeed a modified and degenerate lung, which in the case of those fish which ascend the rivers and invade the land has given place to the lungs, as seen in the gill-bearing amphibians such as frogs, toads, newts and salamanders. In the Sturgeon the inner lining of the air bladder is converted into a gelatinous substance known as isinglass.

No known fish can attain to quite the size of certain extinct Sharks. Those monsters are, however, almost equalled in size by such a creature as the Whale Shark (*Rhineodon typus*), first brought to notice in 1828 and a subject for wonderment and many extravagant stories ever since. The smallest specimen ever taken was 14 feet long, with a girth of $9\frac{1}{2}$ feet and the largest known measured from 40 feet to 60 feet in length. An average example is about 22 feet long with a mouth nearly a yard across, breast fins not far short of four feet in length and a tail fin nearly twice this measurement. Such proportions, coupled with the Shark's jazz pattern of spots and stripes make up a monster that might well strike terror to the

occupants of a small boat, though their fears would be little justified. Though quite capable of capsizing a small craft, the Whale Shark's courage is not proportionate to its size. The mouth could well engulf a man, but the teeth are almost microscopic, the largest in a full-sized specimen being only one-tenth of an inch in length. The teeth, 250 to the row, are arranged in about 15 rows, and their tiny size has led to the assumption that *Rhincodon*



Whale Shark

was a herbivore. It is now known, however, that the food almost wholly consists of minute forms of animal life known as plankton, the enormous gill rays serving to strain off the sea-water just as do certain plates of the Whalebone Whales, which feed in the same manner.

The Whale Shark appears to be more or less cosmopolitan, its immense size rendering travel more or less independent of the ocean currents which largely dictate the migrations of smaller forms. Apparently a solitary

wanderer, *Rhineodon*, has been reported from South Africa, Arabia, the Seychelles, California and the Philippines.

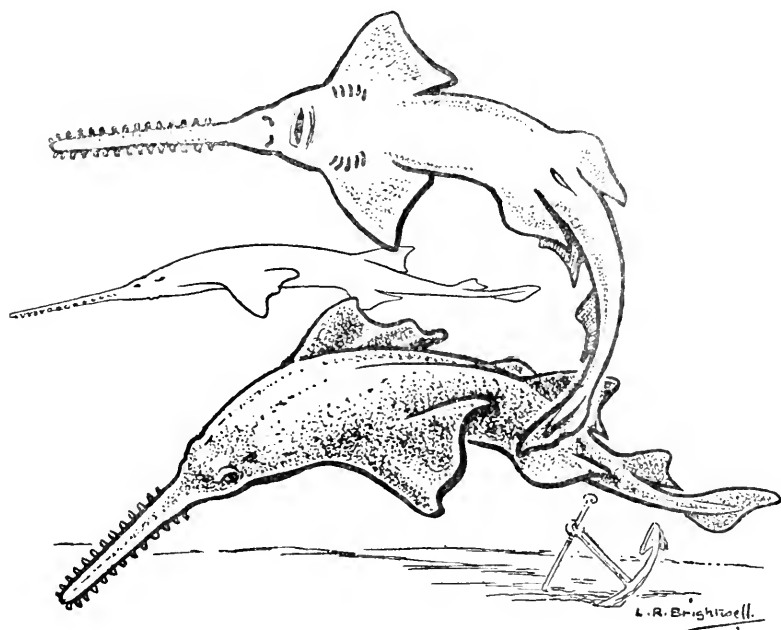
The Basking Shark (*Cetorpinus maximus*) of similar habits to the Whale Shark, reaches 30 feet in length, but favours a more northern habitat, being found in the colder waters on both sides of the Atlantic. A number of the largest specimens have been taken off the west of Ireland and even near Brighton and the Isle of Wight.

Of different calibre are most of the other large Sharks—highly predaceous coastal sea raiders that have too often justified the wild stories told of them. The typical “man eater” is the White Shark (*Carcharodon*), which reaches 40 feet in length and possesses some hundreds of teeth, each $1\frac{1}{2}$ inches long. In one such specimen was found a fully-grown sea-lion, whilst human remains are not infrequently recovered from its expansive interior. In much the same category fall such monster fishes as the Blue Tiger (*Carcharias*) and Hammer-headed Shark (*Sphyrna*), both of which are more or less gregarious and the more to be dreaded since in combination they may run down and tear to pieces creatures which might possibly evade a single specimen.

Of late years systematic attempts have been made to commercialise these fishes and to good purpose. One of the chief centres of this post-War industry is in Australia, whose waters so swarm with Sharks that a look-out man is deemed essential upon all the popular bathing beaches, the Sharks not being deterred by mass humanity or the obstacle of broken water.

In Australia alone six species are recognised as habitually

man-killers, the Sharks becoming specially dangerous at night. Shark flesh, after the oil has been extracted, is used for food, the spinal columns are converted into walking-sticks, and the waste parts employed as fertilisers.



Saw Fish

There is a big export trade of dried fins for soup to China, and the skin is treated to provide many varieties of leather.

Nearly allied to the Sharks are the Saw Fishes (*Pristidae*), which reach an immense size, with saws projecting from the snout for six feet or more. Saw Fish, like many true Sharks, are born alive, the infant Saws being encased

in gelatinous sheaths whilst still within the parent. The skeletal structure of this saw as washed ashore puzzled the earlier naturalists, and as late as the year 1864 they were described as being the dismembered arms of an unknown species of Starfish.

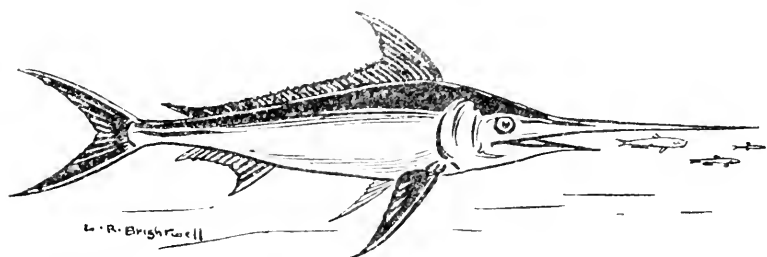
The last few decades have seen the related giant Whip Rays promoted to the ranks of big game fishes. They hail from tropic waters and may average some 15 feet across the "wings," the skin of which is often handsomely marked and in some demand for table tops. The Giant Ray, when taken on hook and line, will put up a fight for half a day or more, towing a small boat many miles. On occasion it may ensure a dramatic finish by leaping high into the air and descending with a weight of well over 1,000 lbs. upon the boat and its occupants.

Most classes of fish can produce giants. Even the Herring tribe boasts of a fish—the Tarpon (*Tarpon atlanticus*) of Florida—that reaches a length of 7 feet and attains a weight of 200 lbs. It has terrific staying and leaping powers that attract the attention and fire the zeal of fishermen the world over. As with many fishes the Tarpon's family life is still largely unknown, but of late years young fish have been found in semi-land locked estuarine waters, one such specimen living for some time in the Zoo's Aquarium in Regent's Park.

Another giant fish is that super-mackerel known as Tunny (*Thynnus*), which during the last few years has in this country seen a meteoric rise to high esteem both as a game fish and a popular food supply. Tunny weighing 1,500 lbs. have been reported, the largest occurring on the farther side of the Atlantic, though whether it is the same

species as that now popular with anglers off the Yorkshire coast is still conjectural.

The Sword Fishes (*Xiphiidae*) may attain a length of 15 feet and are regarded as the swiftest fish afloat. There are well authenticated stories of this fish ramming vessels, and the sword or beak, which may attain a length of over a yard, being left in the ship's side. The results of such an attack once led to a classic lawsuit, in which Sir Richard Owen, called as a witness, stated that the fish strikes



Sword Fish

with the accumulated force of fifteen double-headed hammers, and as dangerous in its effects as an artillery projectile. The sword is two-bladed, being some three inches wide and one and a half inches thick, and will easily pierce a two-inch plank.

The Common Swordfish occasionally reaches our shores and forms a recognised part of the Tunny fisheries catch off North Africa. At such times the fish rush blindly hither and thither, piercing the tunny, each other and the fishing boats, yet without any apparent intent. Of the thousands of Swordfish that have been opened none have

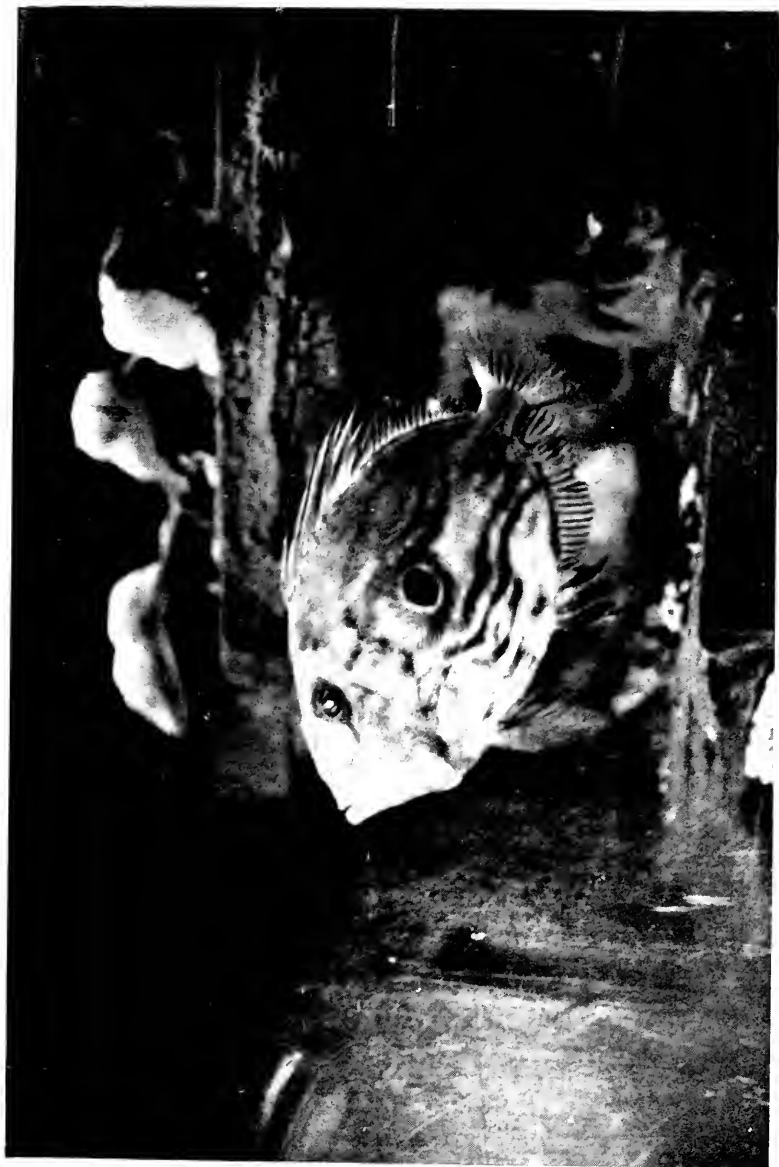
contained anything larger than a sardine, and it is therefore probable that the sword is used mainly to rake up sand and so dislodge the small animals upon which it feeds.

Another giant is that strange creature known as the Oar or Ribbon Fish (*Regalecus glesne*). It has an elongate form extending 20 feet, and its shape combined with the long filamentous spines on the pelvic fins and curiously-shaped head have no doubt done much to make the fish popularly accepted as a sea-serpent. Nothing is known of its eggs, early stages or habits.

The chameleon has from time immemorial been popularly accepted as the quick-change artist *par excellence* of the animal world. Actually its power of changing colour at short notice is easily eclipsed by many other animals, notably fishes. Though the remarkable colour changes in fishes have been noted from early times, their actual significance has been appreciated but recently, and we are only now beginning to fully understand the manner of their mechanism.

Briefly, the colour changes are due to the presence of special pigment cells in the skin, which being contracted or dilated produce various effects. The actual range of pigments is limited, but endless combinations can be formed by the excitement or otherwise of diverse cells in close proximity to one another. Thus the vivid green of the mackerel is due not to the presence of green pigment, but to the juxtaposition of black and yellow pigment cells which operate with varying degrees of intensity.

Recent researches by Professor G. H. Parker, of Harvard University, have demonstrated that these colour phases are brought about by a gland-like action of the nerve



E. W. Bond, photo.

JOHN DORY

facing page 146

endings causing the secretion of a substance called "neurohumor," a substance which is secreted in a range of two opposing systems, the one spreading the pigments through the cellular processes, the other causing them to contract.

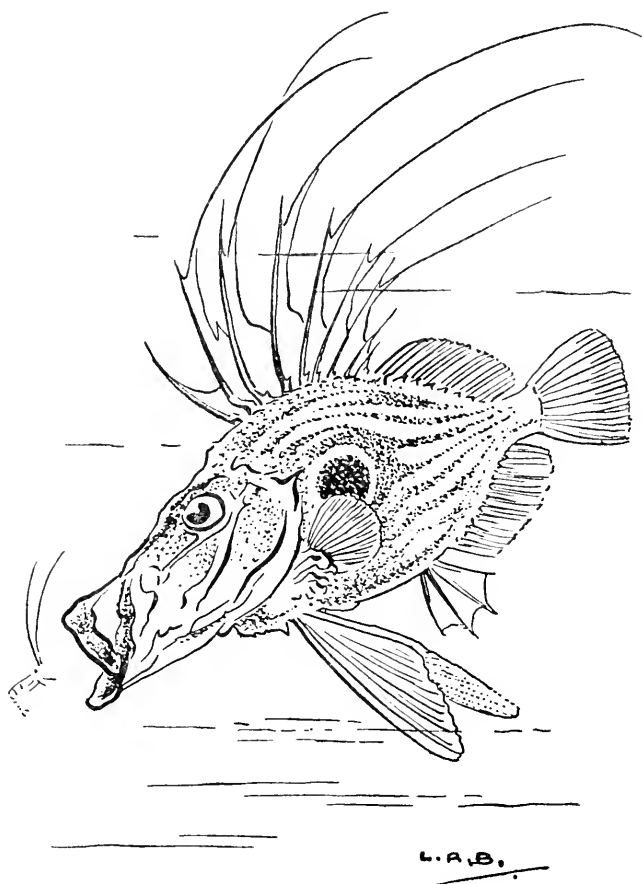
The scientific side of the colour formation will commend itself necessarily to a restricted audience, but the actual effects as demonstrated in public aquaria make a general appeal. Often these colour phases arrange themselves in certain definite patterns, and in the past such examples sometimes became the subject of strange myths and superstitions.

Thus even to-day the dark spherical markings on the side of the John Dory (*Zeus faber*) are pointed to as commemorating the occasion when Saint Peter took the fish between the thumb and forefinger when extracting the tithe money.

In a species of Butterfly Fish common off the Zanzibar coast, certain markings on the tail fins suggest old Arabic characters, and some years ago these were so pronounced in a certain specimen that they actually spelt "Laillaha illalah" and "Shamiallah," i.e., "There is no god but Allah," and "The warning sent from Allah." This fish, normally worth only a penny in the native fish markets, was purchased for 5,000 rupees.

A quaint Arabic legend attaches to the colouring of the Flatfishes, which, as is well known, are pigmented on one side only. According to the native story, Moses was cooking a Flatfish when the oil suddenly gave out. The irritated patriarch flung the half-browned fish into the sea, where it came to life and handed down its peculiar

colouring to its descendants as a memento of the event.



John Dory

These and many similar stories though of interest scarcely explain the *raison d'être* of piscine colouring and colour changes. The emotions and exigencies of life

which dictate fish colour changes are many and varied, but an outstanding factor in their determination is in most cases that of concealment. The inability of fishes inhabiting the abyss to change colour may be explained by the fact that it would serve them no useful purpose. The majority are black or red, colours which in complete darkness are effective cloaks of invisibility.

But with fish that live in constant exposure to varying lights and ever-changing surroundings, the case is very different, and ability to harmonise quickly with whatever scenic environment may offer becomes a necessity if foes are to be successfully eluded. Good examples of the latter are to be seen in the Pike tanks at the Zoo, where the fish, caught in deep and dark lakes and originally dark green in colour, have adapted themselves to the bright sandy colour schemes of their new premises.

In some of the marine tanks startling changes are to be observed. At the Zoo Aquarium systematic experiments have been made with Flatfishes—the most accomplished of the quick-change artists of the underwater world. These fishes if placed in tanks with various coloured floors—even floors decorated with tessellated or geometric patterns—at once accommodate their colours and patterning to blend with their surroundings. It was found that in the case of a Flounder that it copies red backgrounds less accurately than it does blue and green, though brown and yellow are assimilated almost instantaneously.

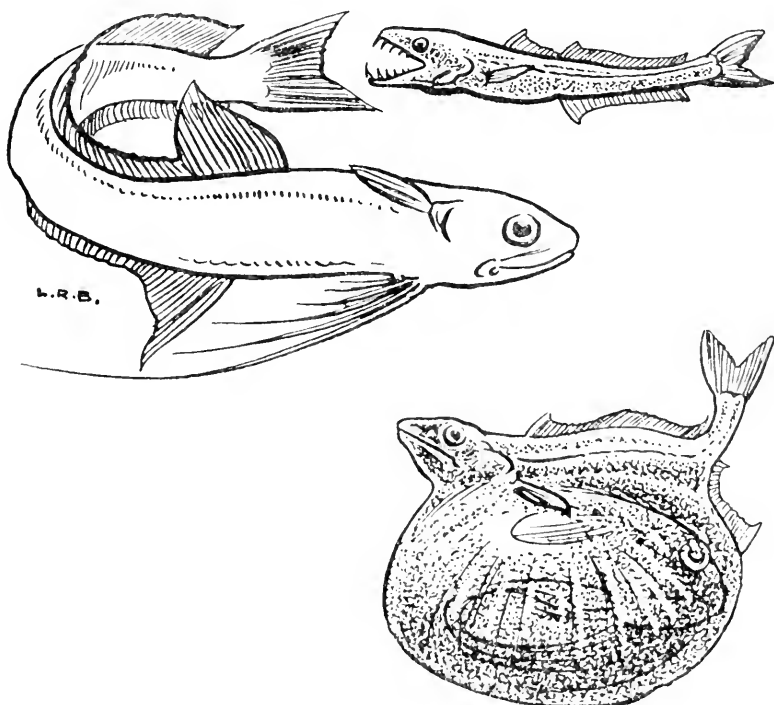
It is amongst fishes living in varied surroundings that changes of colour are the most notable. But though such changes usually have concealment as their motive,

it is not always the case. Many of the "eye-spots" seen in certain fishes are constant as regards position and vary only in intensity. Though explanations must perforce be conjectural, it is suggested with some reason that these serve as "recognition marks" which aid the shoal to keep together. These marks are often more pronounced in the male fish and become greatly intensified by excitement, as produced for instance by the prospect of food or the sudden appearance of a hated rival. Such intensification of markings is very notable in some of the fish to be seen in the Regent's Park Aquarium, and eminent authorities have suggested that their vividness serves to attract or hypnotise the small fish or prawn which the bearer hopes to engulf.

Certain fish, like the Trigger Fishes, which are known to be poisonous, undergo marked colour changes when threatened, and it is possible that such changes spell "danger" in the manner of the skunk's upraised tail or the cobra's expanded hood.

Many fish, the Common Cod (*Gadus morrhua*) for example, are literally living trawls, and the stomach of a Cod Fish of normal dimensions has yielded, besides scores of crabs, small fish and sea worms, stones 4 lbs. or more in weight. The palm for swallowing feats, however, goes to the so-called "Swallower" (*Chiasmodon niger*), a fish from the abyss, which has so distensible an interior that it can, and often does, engulf active fishes of five times its own length and many times its weight. The degenerate abyssal Eels, of the genus *Eurybarynx*, must be equally voracious since the mouth of one such fish measures more than a quarter of the creature's entire length.

It may be said that no part of the sea has defied the colonising efforts of fishes, and even the "deeps," in some instances nearly four miles from the sea surface, have



The "Swallower" (*Chiasmodon*).

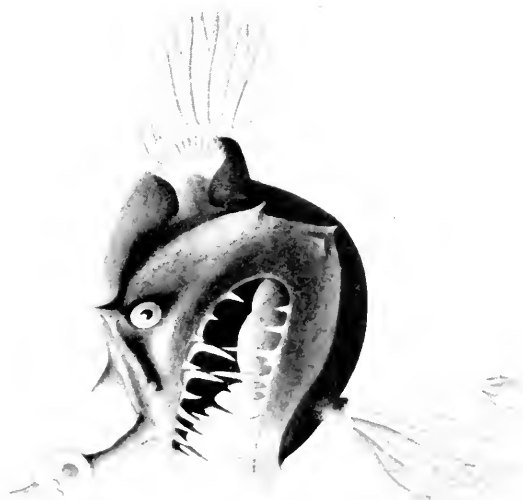
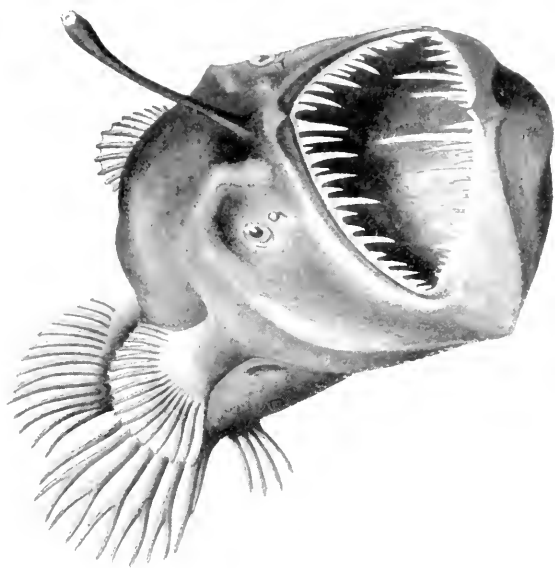
Above, before a meal ; below, after swallowing a fish five times its own size

their own population of piscine forms attuned to their peculiar environment. Abyssal fishes appear to be almost cosmopolitan, identical examples being dredged from deeps on opposite sides of the globe, though how this comes to

pass cannot be properly understood until the ocean depths have been more thoroughly surveyed.

As previously mentioned, the prevalent colours of deep-sea fishes appear to be black or bright red, both sufficiently inconspicuous in a world from which the last light has vanished. The abyss, however, it is now known, is not entirely the world of Stygian darkness it was once assumed to be. Fishes, Corals, Hydroids and a myriad other creatures light the darkness with an eerie radiance. Luminous organs vary from mere collections of light cells generating a luminescent slime to complex batteries, the light from which is augmented by lenses and reflectors which parallel to a remarkable degree many human devices.

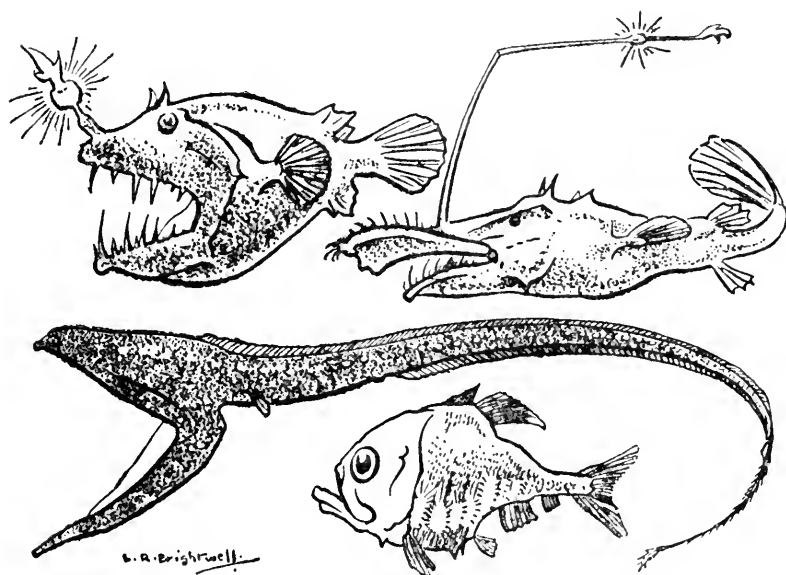
The ways in which such lights may be disposed about the fish are legion. In some cases the entire tegument of the fish is invested, but more frequently the lights are localised. Some fishes carry their light organs ranged in rows along their sides, so that the creature suggests a liner as seen at night with every port-hole brilliantly illuminated. Often the light organs take the form of immense headlights arranged before or behind the eyes ; or again they may be mounted on special rod-like organs. Certain small abyssal Sharks have the whole of the undersurface illuminated so that the fish, which are bottom-feeders, light up the sea-bed as they travel, their lights probably serving the double purpose of a lure and a means of locating animals tempted from their burrows. Light organs reach their highest development in the bony fishes, and in some the reflector is so powerful that it still functions when the animal is actually dead.



DEEP-SEA ANGLER-FISHES



The useful purpose of such light organs to their owners is apparent. Less obvious, however, is the advantage to be gained by luminous teeth as seen in certain deep-sea Anglers, whose enormous fangs advertise themselves to intended victims by a bluish radiance.



Deep-Sea Fishes

One luminous fish (*Photoblephron*), common around the Island of Banda in the Pacific Ocean, is put to commercial use by the local fishermen, who cut out the enormous light organs from either side of the head and use them as bait. The light organs continue to function long after removal from their rightful owner and tempt other fishes to seize the hook which they are employed to conceal.

Whereas the light of many fishes appears to wax and wane according to health—or emotional state of the fish concerned—in some cases it is completely under its owner's control. In some deep-sea fishes the light organ is stationed one just behind each eye, and observation has revealed that the fish possesses a black shutter, like an eyelid, that can be pulled down over the light at will.

The Angler Fishes not only frequently possess light organs of high development, but also present to an unusual degree the development of tactile organs, which play so important a part in the economy of many fishes. Sense organs of this category are seen in many common fishes, the Cod (*Gadus morrhua*), Red Mullet (*Mullus barbatus*), and all Catfishes having barbels depending from the chin, which restlessly probe the sea-bed and notify their owner of anything edible which may lie in its path. In deep-sea Anglers and some other oceanic fishes, the barbel takes the form of a most complicated beard divided and subdivided into innumerable ramifications, with the result that a veritable bush is the result. Such organs are of special service to fishes living in muddy waters, when the general density of the surroundings obliges the animal to live in a perpetual state of low visibility.

Light and sense organs have a very direct bearing upon the faculty of vision. The depth at which a fish lives and its general mode of life may indeed frequently be gauged with some accuracy by the development of its eyes. Fish frequenting a muddy bottom usually have small eyes, sight being of small avail in highly turbid surroundings.

The Lampreys (*Petromyzon*) and the Hag-fishes (*Myxine*) have likewise poor sight, but for quite another reason.

These fish habitually seize upon and burrow into the sides of other and larger fishes, often penetrating so deeply into the victim that the eyes become hidden, and as a result these organs have become practically little more than vestigial.

Surface-dwelling fishes or forms inhabiting mid-depth where light generally penetrates have normally developed eyes of average size ; but in the depths one is confronted with what at first appears to be an anomaly. Here there are fishes with gigantic eyes living side by side with others having very feebly developed organs of vision. The large-eyed fishes of the abyss generally have little in the way of luminous organs and it is believed that they rely for visibility upon the innumerable invertebrate animals, which, as previously mentioned, are in many instances known to be luminous to a degree.

Light, it is now known, is not entirely absent until one reaches a depth of nearly 2,000 feet, and there is no marked deterioration in the eyes of fish until this depth is reached. So long as light is present at all fishes appear to make use of every available ray. Complete blindness is indeed a very rare condition in marine fishes. An example is that of the Blind Goby (*Thylogobius*) living on the reefs fringing the shores of Southern California. Here it fastens itself to the undersurface of rocks or penetrates into the ready-made burrows of crustaceans. The fish presents the features characteristic of animals which thus seek retirement. It is small, pale in colour, has a smooth, naked skin and is blind. The eyes though small are present in the young ; they function normally in infancy, but deteriorate into mere vestiges hidden beneath the skin

as the fish attains maturity. A particularly interesting feature of this fish is the very obvious cause of its retrograde development. Several other species of closely similar Gobies frequent the same reef and similarly seek refuge in the burrows of crustaceans. But whereas these forms enjoy a wide range and only take shelter when danger threatens, the blind species is highly localised and never leaves its retreat. It is evidently therefore a degenerate relative which has paid for its want of enterprise in the loss of eyesight and generally poor development.

Few subjects have been more obscured by poetic fancy—as opposed to scientific fact—than have the migrations of various animals. As regards fishes, accurate data is still lacking as to the precise movements of many quite common species, though in this direction up-to-date research with all the wonderful appliances now at its command is making remarkable progress.

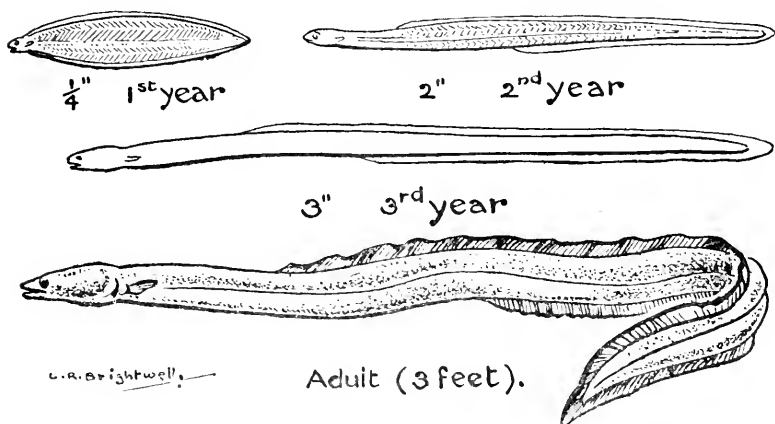
The latest work in this direction has been undertaken by the French Government, who recently sent a fisheries research mission into the Atlantic under the directorship of Monsieur Jean le Danois. The expedition asserts that there is evidence that Great Britain once joined the European continent, and that the Rhine once had its outflow near the Firth of Forth, an assertion which casts an interesting light on the movements of two fish, namely the Haddock (*Gadus aeglefinus*) and the Tunny (*Thynnus thynnus*), which have long been known to make periodic journeys from the Atlantic into Continental waters. These fish, one would imagine, would, in order to enter the North Sea from the Atlantic, take the short cut offered by the English Channel. They, however, still travel

laboriously round the north of Great Britain just as their ancestors must have done countless centuries before the Channel came into being.

The Salmon (*Salmo salar*) is another fish that illustrates to a remarkable degree the conservative manner in which certain fishes direct their courses. As is well known, this fish although spending some years in the sea, invariably returns to the river of its origin when the time comes to propagate the species. The late Frank Buckland has given a remarkable instance of this blind homing instinct in a letter published many years ago. He wrote: "A friend of mine who owns a well-known island on the west coast of Scotland netted a certain pool in his fishing and out of a number of fish caught he carefully marked some twenty or thirty. He then put these fish on board his yacht and sailed right round his island, then up a creek to the mouth of a river. The Salmon were transferred up the river, which although close to the river in which they were caught was in no way connected with it, having a different watershed. It is as though the Salmon had been carried from one heel of an enormous horseshoe round to the other heel and then taken right up into the middle of the horseshoe and let loose. During the season that these fish were transferred some of the marked fish were caught in their own pool with a net and one with a rod. On examining the map I find that these fish must have come back again to their own river, a circuit of forty miles at least from the lake where they were turned out, and they must have passed six or seven tributaries which they did not ascend, although there was nothing to prevent them."

Perhaps the most remarkable of all fish migrations

because it is the longest is that of the Eel (*Anguilla vulgaris*), which makes its way from its nursery in the West Indian waters to the opposite sides of the Atlantic. The Eel in fact reverses the Salmon's programme, breeding in the sea and resorting to fresh-waters for food and growth. For centuries the complete life history of the Eel and its origin was a mystery and the subject for much



Development of Eel

speculation, and it is only as the result of careful research in recent years that the mystery has been solved. Pliny and Aristotle believed that Eels originated from mud at the bottom of the sea and that they had no sex; whilst other curious beliefs were that the fish originated from horse hairs dropped from the animals' tails when wading in the water, from maydew, from the gills of other fishes and from aquatic beetles.

It was not until the year 1904 that Dr. Johannes

Schmidt conclusively traced the Eels' breeding grounds to a region of the West Atlantic south-east of Bermuda, where the water is 3,000 fathoms or more deep. On hatching the infant Eel in no wise resembles the form of its parents, being flat, leaf-shaped and transparent. When a few months old these tiny creatures leave their birthplace and, ascending towards the surface where they meet the eastern currents, are swept along towards European shores. For three years they travel slowly onwards, moving four or five miles a day in a journey eventually covering about 3,000 miles. It is not until the third year, when they measure about three inches in length, that they begin to alter in appearance and become round-bodied fish. They are then known as Glass Eels or Elvers. Their journey by sea completed, the invading hosts of Elvers make their way inland, ascending rivers and streams undeterred by any obstacle however formidable. They scale lock gates, wriggle up the boulders beside waterfalls, and sometimes even travel overland when the ground is damp. Eventually they find their way to those ponds, ditches and lakes which must constitute a haven of peace after their prolonged travels. Here they settle for from five to eight years, when the mysterious call of the sea summons them back to their birthplace. They then once more set out on their stupendous journey through fresh-water and salt to the depths of the Atlantic from whence they came. Their return, however, is the completion of their life cycle, for after spawning death ensues and another multitude of larval Eels are setting out on their tremendous journey.

The breeding ground of the nearly related American

Eel (*Anguilla rostrata*) is situated in proximity to that of the Old World species, the larval stages of both forms having been taken in the same haul of the net. But whereas the latter takes three years to cross the Atlantic, the former's journey to its native ponds and rivers is completed in a single year. How these minute larvæ can decide upon which direction to take, whether an easterly or westerly one, is an unfathomable mystery. In the case of the Eel the migratory routes are probably not determined by custom as in the case of the Haddock, but by physiological changes in the fish themselves, which demand certain chemical conditions of the water.

In other fishes the sudden or gradual change of food supply and the irresistible forces exercised by the great ocean currents, play their parts in determining the way of a fish in the great waters. Only a few giants of the race can be more or less independent of such factors and shape their courses as their inclinations dictate.

The expression "parasitism" is often loosely applied to animals, and especially to fishes. The word is frequently used to describe creatures which live together, whereas the true parasite attaches itself to the host and lives solely at his expense and often to his ultimate undoing. True parasitic fish are not abundant, the best known are various species of Lampreys and Hagfishes, some of which were once recognised food supplies in this country. The Lamprey is of primitive construction, having no true jaws but a round suctorial mouth armed with numerous horny teeth. By means of this structure, the creature attaches itself to some larger fish and literally tunnels into the flesh, at the same time drinking the blood until replete. In

this way it can, and often does, kill such vigorous fast-swimming fishes as the Salmon and Sea Bass.

Certain South American Catfishes (*Pygidiidae*) attach themselves to other fish or even large animals entering the water, piercing the skin and drinking the blood, much as the Vampire Bat attacks its victim. Some allied forms enter the gill cavities of large fishes and use both teeth and sharp spines to excite a blood flow from their unwilling host.

The only other case of parasitism is that of a deep-sea Angler referred to later. Here the parasitism is rather of a commensal nature since the race depends upon the male quartering himself upon his gigantic spouse and tapping her bloodstream for his own immediate sustenance.

False parasitism is that wherein two widely different creatures live together for the joint well-being, forming as it were a co-operative society. The only instance met with in marine fishes is that wherein colonies of Hydroids attach themselves to certain fishes, thus warding off foes and at the same time catching minute scraps of food discarded by the fish when eating.

Partnerships in which the tenant comes and goes at will without conferring any special benefit on its landlord or protector are not uncommon. A remarkable instance is that of the Florida Cardinal Fish (*Apogonichthys*). It lives in the mantle cavity of the Sea Snail known as the Fountain Shell, the fish entering and leaving its host at will, causing no little inconvenience. Several species of Goby enter Sponges, using the sharp jaws and bi-lateral series of scales to climb up and down the long tunnels of the Sponge's interior.

A better known partnership is that of the Mediterranean *Fierasfer* that lives inside large Sea Cucumbers. Yet another familiar example is that of the Coral Fish (*Amphiprion*), already described in the chapter on Coelenterates. Also amongst the gate-crashers is the little fish *Nomeus* that shelters amongst the stinging cells of the justly dreaded Portuguese Man-o'-War, and the Horse Mackerel that takes up its abode beneath giant Jellyfishes.

Commensalism is a term applied to creatures that actually feed at the same table, as in the case of the Hermit Crab and Anemones mentioned earlier. It is doubtful, however, whether some of the fishes often placed in this category have any right to such a position, since they apparently bring no food to their host, neither do they share his meals, but merely benefit from such protection as may be afforded by its large size, armature, stinging cells, or other defensive weapons.

A good host must, one imagines, find the benefits he offers at times somewhat embarrassing. Thus the Sea Cucumbers sheltering *Fierasfer* may on occasion be invaded by seven of these fish at one time, and according to Dr. William Beebe the Jellyfish common in Bermuda, though measuring only four inches across, is at times called upon to accommodate over a dozen small fishes known as "Bumpers." These fish are evidently sheltered at some risk, for in the event of their coming into contact with the stinging cells they at once forfeit their life and provide the host with a repast.

The most famous of all these so-called parasitic fish is the Sharp Sucker or Remora, a fish previously referred to when discussing the subject of fins.

To the thoughtful student it must be a matter for continual surprise that whereas the Reptiles, which are biologically much more highly constituted animals than the Fishes, show little or no solicitude for their families, the Fishes both in their courtship and care for the young often ascend to heights scarcely surpassed either by birds or mammals. Although the fish populace of the seas greatly exceeds that of the fresh-waters, few of its teeming thousands show that care for their offspring which is characteristic of many inhabitants of lakes or rivers.

Throughout the seas, actual courtship usually consists of swimming round and round the female, prodding her with the snout, pulling her fins, or where the fishes' make-up so permits intertwining bodies. Though the male at such times may be excited to the last degree of frenzy, there appears to be no lasting affection as with many birds or mammals and a new partner is sought automatically the next season. How intensive male rivalry may be at times is well evidenced in the case of a certain perch-like fish found in Hawaii. Fishermen turn the male's pugnacity to account by tethering an excited swain near concealed nets and in due course other males are quickly attracted to the spot and trapped.

The making of a home or otherwise is dictated largely by the "number in family." Where the ova are broadcast by the million any attempt at home-making is obviously impossible. Such eggs are allowed to drift at the will of wind and wave, buoyed up by their own oily globules. Only mass production can ensure any such eggs surviving to hatch into fry or the fry attaining to maturity and so

continuing the race. It is estimated that only one in a million Cod's eggs ever reach Codhood.

One of the most prolific of all fishes is the Ling (*Molva*), a single five-foot female weighing 50 lbs., yielding over 28 million eggs.

Care of any sort for the eggs, indeed, seems to be in exact inverse ratio to the number produced. Though whilst the Ling's gigantic brood is turned adrift the Herring's comparatively modest quota of from twenty to forty thousand are in some measure provided for. They are heavier than the surrounding water and sink in clusters until they fall upon shingle, where they become attached by their adhesive covering. This same crude form of attachment is carried to more elaborate lengths by fishes producing small batches of a few hundred or scores only of eggs. In the Sharks and Rays the eggs are often of large size and enclosed in horny capsules, having wiry tendrils or other attachments for anchoring them securely amongst silt or weeds.

It is interesting to note that in certain viviparous Sharks—amongst the few live-bearing sea fish—the embryos are at first contained in very thin egg capsules which become absorbed prior to birth.

The egg cases of our native Dogfishes and Rays are familiar to all as "Mermaids' Purses." In the deep-sea *Chimeras* the egg capsule is shaped like an enormous tent-peg, with the pipe thrust deep into the silt of the sea floor.

Adhesive eggs are less common with sea fish than with those of fresh-water, in which adhesion is the rule. The eggs of the Lamprey have a bunch of adhesive threads

at one end, which anchor them securely to solid objects.

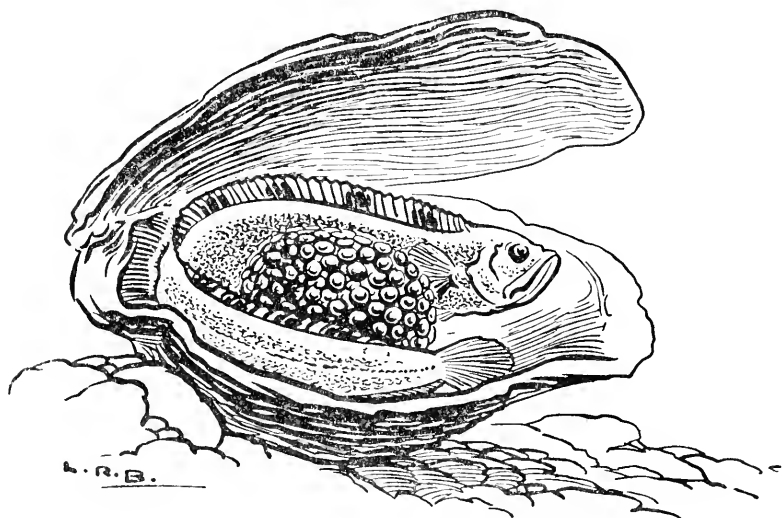
The simplest attempt at nest-making amounts to no more than the excavation of a shallow depression in the sea or river bed. The Salmon, which is both fresh-water and marine, ascends a selected river in the pairing season, and with its fins and body makes a shallow trough for the deposition of the eggs, a labour which leaves lasting evidence upon its scales. The primitive Lampreys, on the other hand, effect nest-building by laboriously lifting stone by stone in their suctorial mouths, male and female combining to lift particularly heavy boulders.

A further step in nest-making consists in roughly pushing together scraps of weeds, etc., until they form a more or less globular mass, which the male hollows out by tunnelling into and so forming a safe retreat in which his partner can deposit the eggs. The marine Stickleback (*Spinachia*) and many of our native Wrasses (*Labridae*) make nests of this description, though in compactness and finish such efforts fall far below the standard of the Common Stickleback (*Gasterosteus*) of our ponds and ditches. It is noticeable that in by far the larger proportion of such nesting efforts the labour devolves almost entirely on the male, the sexes rarely combining in family duties. Still more rarely do they fall to the female, apart from the actual deposition of the eggs.

The most popular form of nest-making amongst sea fishes is the selection of a ready-made retreat as offered by a rock cranny or empty mollusc shell. Various Blennies, Bullheads and Sand Gobies, all small coastal fishes abundant between tide limits, habitually make such

homes, the male as usual undertaking the responsibility for the family's safe development.

The Butter Fish, or Gunnel (*Pholis*), usually selects an oyster shell, the Butterfly Blenny (*Blennius ocellaris*) that of some larger univalve, whilst the Common Blenny (*Blennius pholis*) may even make shift with a hole in a wooden

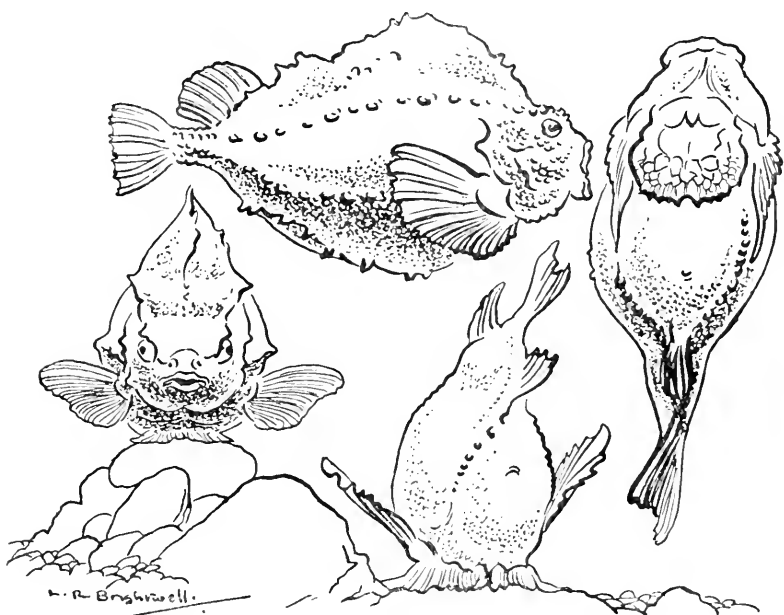


Butter Fish and eggs in oyster shell

breakwater. In all such cases the male mounts guard, blocking the doorway with his large head and intimidating all comers with a ferocious display of distended fins and inflated gill covers. The Common Sand Goby (*Gobius minutus*) goes a step further. Deliberately turning over some discarded bivalve shell so that the concave side is downwards and then, worming his way beneath it, he hollows out a small chamber having one tubular connection

with the world without. The hole is then cunningly concealed with sand whilst he goes in search of a partner.

Most of these fishes are content with quite small families, but the Lump-sucker (*Cyclopterus lumpus*) deposits from eighty to one hundred and thirty thousand eggs in some



Lump-suckers

convenient rock fissure. The eggs, often exposed at high water, are guarded by the male, for some months if need be, during which time he continually turns them about with his head, aerates them by fanning them with his fins, and blows water over them with his mouth. The father seldom survives the arduous duties since he never feeds throughout the whole term of nursing. Invaders in the

form of Whelks, Crabs or Starfish are at once hustled



Common Sea Horse

from the vicinity with a complete disregard for danger.

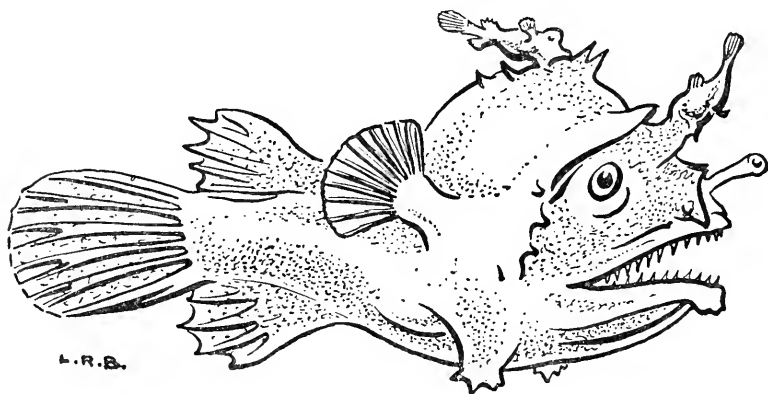
A tempest may scatter the eggs far and wide, when the dauntless parent frantically attempts to collect and re-assemble them.

Sea Horses, represented on our coasts by the nearly-related Pipefishes (*Syngnathidae*), take extraordinary care of their progeny. There is first an elaborate courtship, in which the fish intertwine their bodies, the male caressing his partner with his tubular snout. Finally the two interlock and the female presses the eggs into a kangaroo-like pouch situated on her consort's abdomen and composed of two large flaps of skin which overlap. Here the eggs remain until ripe, when the male liberates the fry by bending his body, or even manipulating the skin flaps with his tail. The emergent young do not, however, leave their parent immediately, for often they cluster about him, perching on his attenuated person by means of their long prehensile tails.

Most remarkable of all sea fish nurseries is that of the Gaff-topsail Catfish, a species ranging along the South Atlantic coast. The male imitates certain fresh-water fishes in carrying its eggs in its mouth, some fifty odd ova being thus incubated, the young remaining with the parent some time after they have hatched. The eggs are very large in proportion to the fish, and fry four inches in length have been found in the mouth of a twenty-inch parent. How the eggs are fertilised and placed in the paternal mouth is not at present known. They are probably—as in the case of the Egyptian Perch (*Paratilapia*)—laid on the floor and picked up by the parent.

As previously mentioned, fish partnerships appear to be of one season's duration only, but there is a possible

exception, though the precise length of time during which the interested parties live together is at present unknown. Within the last few years it has been discovered that the male and female of certain Angler Fishes inhabiting the deep waters of the northern hemisphere become permanently united. Females have been discovered with minute



Deep Sea Angler Fish with parasitic males

males—only one-tenth of their partner's bulk, attached by the head to various parts of the body. The identity of the male in its free-swimming state has not been satisfactorily established, but it is evident that he at first grips the female with his jaws, the site of location being a matter of chance. Once attached he grows on to his partner, sharing her circulatory system, and in time becomes so completely one with her that practically all his organs save those vital to the fertilisation of the ova are reduced to vanishing point.

CHAPTER IX

REPTILES

DURING their heyday many millions of years ago, Reptiles presented an extraordinary abundance of maritime and estuarine forms. Some of these almost rivalled the largest whales in bulk, and in conformity with their marine habitat often developed upon those same lines which have made marine whales the supreme monsters of the ocean world. The huge Mosasaurus and many others could they have survived to-day would doubtless have been mistaken by most people for huge cetaceans. To-day the marine Reptiles are reduced to a mere handful. Only a single Crocodile, five Turtles, a solitary species of Lizard, and some fifty kinds of Sea Snakes are known.

Marine Reptiles are essentially inhabitants of the warmer waters, reaching their maximum developments both in size and number of species in proportion to the heat of their environment. Most of the marine species are purely aquatic, and of the others the majority come ashore only for the purpose of laying their eggs.

In many a systematic review of Reptiles the Chelonians, or Tortoises and Turtles, take pride of place. True Turtles are all marine and the largest of them is the Leathery Turtle (*Dermochelys coriacea*). Like other Turtles

it has the feet developed into paddle-shaped flippers devoid of claws, giving the animal great swimming powers and enabling it to venture far out to sea.

The Leathery Turtle is the only representative of the family *Sphargidae*, and is the largest of living Chelonians. It differs from all other Turtles, Terrapins and Tortoises in its vertebræ and ribs being entirely free and not fused with the carapace. The body is protected by a shield of mosaic-like bony plates and this is covered with a thick layer of leathery skin, which in adult specimens is perfectly smooth. In colour it is dark brown, more or less distinctly spotted with yellow. The Leathery Turtle though smaller than some extinct species is now the giant of its race, its shell sometimes measuring $4\frac{1}{2}$ ft. in length. The animal may attain 6 ft. overall, with a span of 10 ft. across the fore-flippers, and a weight of half a ton.

It is almost carnivorous, feeding on molluscs and crustaceans and is confined to the tropic seas of the New World. This Turtle is of no market value, many regarding the flesh as definitely unwholesome, so that it suffers little molestation even when in spring it comes ashore off the northern coast of Brazil, where, like other Turtles, it buries some hundreds of eggs in the sand.

Before laying, a depression is made, the eggs being placed in it and afterwards covered by a scythe-like movement of the flippers. In the breeding season some hundreds of Turtles may struggle far up the beach, their bodies making deep parallel furrows as though a huge plough had been at work. Like most young Reptiles, the newly-hatched Turtles are miniature replicas of their parents. Their journey down to the sea is a hazardous one, large

crabs, monkeys, racoons, and birds preying upon them, and of those who successfully run this gauntlet few survive the attentions of large predaceous fishes.

The strength of the Leathery Turtle may be appreciated by the following account which has been given by Mr. G. W. Gourlay of the capture of a specimen at Santa Barbara: "The turtle was first seen swimming on the surface about two miles off shore. I went after it, accompanied by a boy, in an eighteen-foot sailing boat. On approaching the turtle I dropped the tiller and got forward with the gaff-hook, swung over the side, and got the hook fast in the leathery part of his neck. He immediately sounded, and ran out the full length of the line—about two hundred feet—towing the boat about half a mile further out to sea. He then came to the surface and we pulled up close to him again. When he caught sight of the boat he turned and came towards us and threw his flippers over the gunwale of the boat, nearly capsizing her. I climbed up on the upper side, and shoved him off with an oar, the end of which he grabbed and bit off like a piece of cheese. His movements were very swift; using his fore-flipper he could turn almost instantly from one side to the other, and his head would project about eighteen inches from the body. I succeeded at last in throwing a noose over his head, and later, by attracting his attention in the opposite direction, got ropes round both flippers. Finally, having five lines on him, I started to tow him towards the shore. We were from 11.30 a.m. until 4 p.m. in finally landing him. When about half-way to shore he suddenly turned, and made a break out to sea, towing the boat stern first, with all sail drawing full, for

several hundred yards, with little effort. He emitted at intervals a noise somewhat resembling the grunt of wild boar."

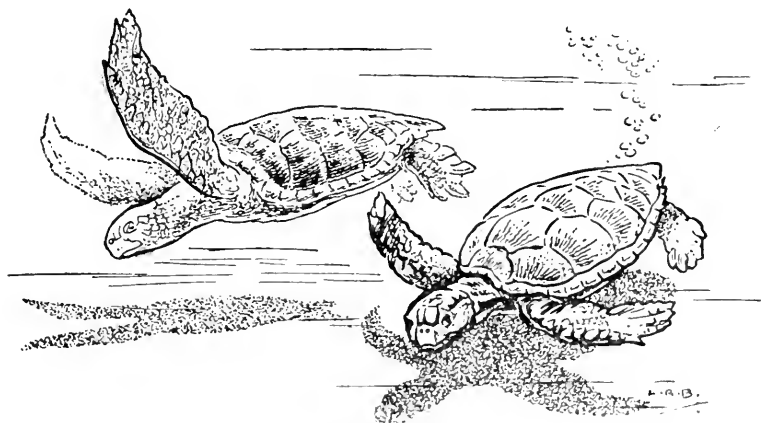
The true sea Turtle family, *Cheloniidae*, is represented by the common Loggerhead Turtle (*Caretta caretta*), Kemp's Loggerhead Turtle (*Caretta kempii*), the Green Turtle (*Chelonia mydas*), and the Hawksbill Turtle (*Chelonia imbricata*).

The Loggerhead, though generally similar to the Green Turtle, is distinguished by a relatively larger head and the presence of two well-defined claws on each of the front flippers. Giant specimens have a shell 4 ft. long and weigh over 500 lbs. Like that of the Green Turtle, its flesh is edible, but is of inferior quality, dark red in colour and flavoured not unlike beef. It is very prolific, laying fifty to a thousand eggs. These like those of other Turtles are both in shape, size and colour like ping-pong balls, but with elastic leathery shells. They can even bounce without breaking. Normally the eggs hatch in about eight weeks, but large numbers are collected for the market, the hunters "sounding" for them by probing the sand with pointed sticks. The newly-hatched Turtles, at birth about the size of half-crown pieces, frequent inland shelters until strong enough to face the open seas.

Like Tortoises, Turtles are very tenacious of life, and can subsist for weeks without food. The jaws, enclosed in razor-edged horny sheaths, are of enormous power, a medium-sized Turtle being capable of severing a broom-stick with no appreciable effort.

As in Tortoises, the male is generally distinguished by a slightly longer tail and a distinct hollow in the hinder

portion of the plastron or undershell. This undershell is relatively soft and elastic and being nearly flat the weight of the animal resting upon it when stranded will, if continued for long, lead to impediment of breathing and circulation. "Turned Turtles," therefore though rendered helpless, stand a better chance of life in transit.



Green Turtles

By sudden expulsion of the breath stranded Turtles emit a deep roaring sound. In the Green, Leathery and Loggerhead Turtles the shell is of little value.

As with most aquatic reptiles, their intelligence is not great, though in aquaria at least they have proved capable of associating cause with effect to a limited degree. In the Amsterdam Zoo it once chanced that shortage of tank room necessitated associating a shoal of mullet with a number of Green Turtles. As a preliminary to the fish's introduction, the water was beaten and much disturbed,

and the Turtles apparently regarding the mullet as responsible for the disturbance treated the newcomers with respect. When the mullet were later removed the Turtles apparently pined, but at once recovered spirits and appetite when the fish were returned. When, however, some new mullet were added to the apparently "happy family," these were quickly singled out and devoured.

The Green Turtle's commercial value is well known, and this choice commodity is in season the year round. It is found in all tropic and semi-tropic seas, but the largest and choicest come from Ascension Island. The majority captured are females, which are waylaid on their journey from the breeding grounds back to the sea. The flesh is cut into strips and slowly sun-dried, when it looks like translucent leather and commands a wholesale price of about 16s. per lb.

The handsome Hawksbill Turtle shows a beautiful patterning both of shell and limbs, even before being subjected to the polishing expert who gives the well-known brilliance with a mixture of goldsize and oil. The Hawksbill, another cosmopolitan wanderer of all tropic seas, is hunted the year round and the horny plates overlaying the shell are removed by heating.

Turtles, which are believed to live to a great age, grow very fast in their early days. Green and Hawksbill Turtles in the Zoo Aquarium which now weigh one hundredweight each, were not much larger than a man's hand when they arrived at that institution some ten years ago.

In the later portion of the "Age of Reptiles" both Turtles and Crocodiles presented a much greater variety and size than obtains to-day. Fossil remains of both

show them to have enjoyed an almost world-wide range, pointing to a wider distribution of genial conditions. Some of the Crocodiles must have attained vast proportions, teeth found in the Kemridge Clay of Ely measuring four or five inches in length.

The only Crocodile frequenting the open sea to-day is the great salt-water Crocodile, *Crocodylus porosus*, this proven man-eater, ranging along the coasts of India, Ceylon, Southern China, the Malay Archipelago, the Solomon Islands, and Northern Australia. It not only takes to the open sea but avails itself of brackish and fresh waters, thus making its way amongst the mass of islands and even travelling overland by way of a short cut from one sea to another.

It grows to a length of over 30 ft., and is distinguished from other Crocodiles by a large bony prominence or ridge in front of each eye. Old specimens are dark olive brown or black, and in common with all other species the mouth is cream coloured or dead white. The gullet may be closed by a movable flap, enabling the mouth to be opened under water, whilst the eyes, ears and nostrils can be similarly rendered water-tight.

Little seems to come amiss to it in the way of animal food, its method of attack being to seize with the jaws, and then if the prey be too large to be swallowed whole, dismembering by a series of sideways twists and wrenches. The claws may also be brought into play.

As with other four-footed aquatic Reptiles, the limbs when swimming are placed close to the sides, motive power being supplied solely by the powerful tail. On occasion it can emit a loud hissing noise and long periods of con-

finement bring no modification to its naturally ferocious disposition.

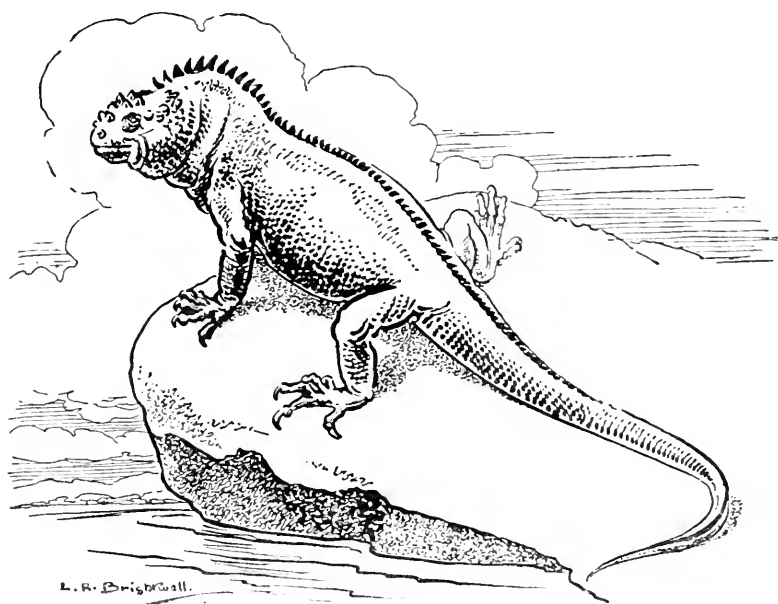
In India and elsewhere its depredations have led to Crocodile-hunting ranking as a well-paid profession, payment being made according to size or the evidence of human victims as shown by bangles, nose-rings, etc., found in the quarry's interior.

Like other Crocodiles it lays large numbers of elongate eggs buried in sand or debris, and a bounty is likewise offered for the destruction of these. Unconscious friends of man are the big monitor lizards, which probe the ground with their lancet-shaped heads and extract large numbers of Crocodile eggs.

The Marine Iguana (*Amblyrhynchus cristatus*) confined to the Galapagos Islands is unique in being the only salt-water lizard in existence, and has been the desideratum of every zoo since it was first described in detail by Charles Darwin in 1832. In appearance this quite harmless Reptile is a veritable dragon. Adult males reach $3\frac{1}{2}$ ft. in length, are black in colour and develop in the breeding season, complex blotches of a metallic green and red. A row of large spines runs from the neck to the tail-tip. The body is generally tubercled and the head bears large conical knobs. The dragon-like appearance is further enhanced by the Reptile sometimes blowing thin jets of vapour from its nostrils. In temper and way of life few creatures can be more harmless, and in fact it is so little used to molestation that it gathers sociably about chance explorers.

Though sometimes solitary or living in pairs, it generally congregates in herds of a hundred or more. It scrambles

about the rocks, its stout claws making it possible to maintain its foothold even when huge waves break over it, creating a backwash that would dislodge the average man. Although obliged to seek its food—a species of sea lettuce—



Sea Iguana

on the sea-bed just beyond the breakers, this lizard prefers to spend most of its time basking on the rocks, a preference which has been suggested by Darwin may be explained by the fact that in the water the lizard has good reason to dread the numerous sharks. When picked up by the tail it never attempts to bite, but when very frightened

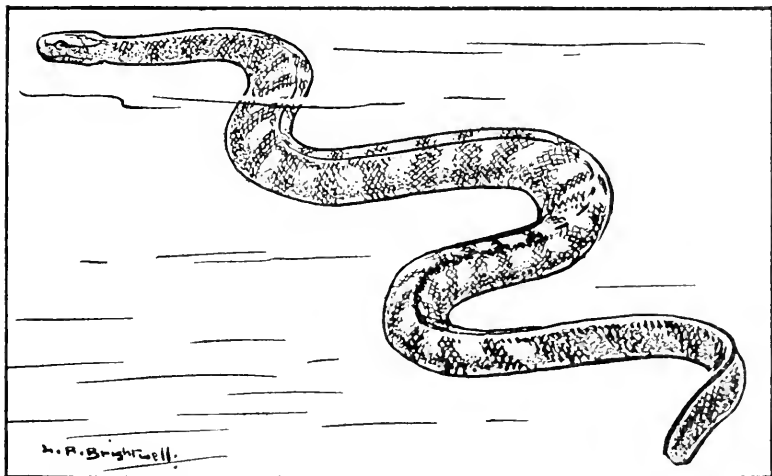
may squirt a jet of fluid from its nostrils. Its only sound is a hiss.

The problem of feeding this interesting lizard has proved the chief stumbling block to keeping it in captivity. Some brought to the New York Zoo several years ago persistently refused to feed and died after a few weeks. The few obtained by Lord Moyne in 1933, however, and presented to the London Zoo, lived for nearly two years. After much experiment they were at last "suited" with the common lava *Porphyra*, an inshore weed regularly collected on the Devon coast and sent for human consumption to Wales.

When Darwin visited the Galapagos Islands nothing was known of its breeding habits, but it has now been ascertained that it deposits in June and July six to eight white elliptical leathery-shelled eggs, which are placed in shallow excavations in sand well beyond high tide level and exposed to the sun. Some very small Marine Iguanas are in evidence about December, the incubation presumably taking some considerable time. Sea Iguanas are still fairly abundant on all the islands in the Group where wild dogs are not present.

The subject of Sea Snakes at once calls up visions of terrific monsters such as all true believers in the ideal sea-serpent would like to meet, or at least witness from a safe distance. Whilst some of the world's largest serpents, however, such as the Reticulated Python of the Far East and the Anaconda of Brazil, are largely aquatic, the only truly aquatic serpents do not exceed 6 ft., and such developments are attained by only a few of the fifty odd at present recognised.

Of these the vast majority are confined to the seas of India, Malaya, Japan and Australasia. Only one species is found in the waters of the New World, and this is the Yellow-bellied Sea Snake, *Hydras platurus*, sometimes seen off the west coast of South America. In common with other members of the order this serpent is slender, eel-like,



Sea Snake (*Hydrophis*)

covered with very small scales, and having the tail flattened vertically to form an effective paddle. Many Sea Snakes are vivid in colour and ornamented with stripes or similar patterns that harmonise with the ripples and waves, thus serving as camouflage.

In some areas these serpents literally swarm, swimming at the sea surface in large numbers and often being washed up dead by thousands after severe storms. The majority are highly poisonous.

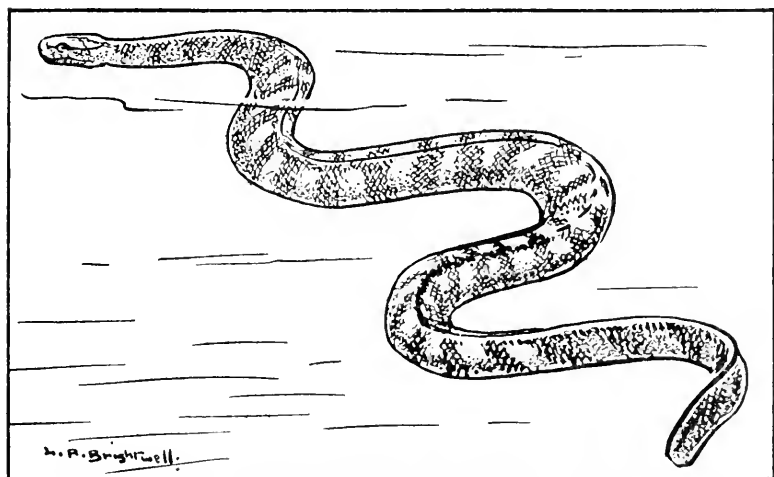
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Sea Snakes do not as a rule flourish in European aquaria, however carefully attended, but in the more genial environment of the Madras Aquarium, where they always figure as common examples of the local fauna, they lend themselves well to observation.

It was found that they lived peaceably with savage *Muraena* Eels and small sharks, getting rather less than their share at meal-times. When given live fish the prey succumbs to their poison within only a few seconds of being struck. When the prey was large, engulfing took several hours, digestion being a matter of instalments. The head and shoulders of the fish were first dissolved before the tail protruding from the snake's mouth could be accommodated. Spiny fish were always avoided and a species of small Sea Perch was not only unmolested, but allowed to scrimp the scraps of food amongst the writhing coils of a dozen hungry serpents.

In common with big Sharks, Turtles and many other sea animals, Sea Snakes are often partially covered with both acorn and stalk barnacles. Whereas most animals so encumbered suffer inconvenience, the more fortunate snakes are periodically able to rid themselves of these nuisances by casting their old skin, which they do in one piece. For some time prior to this operation the snake lies passively just under the sea surface. Presently it acquires a new suit and regains vigour and appetite.



F. W. Bond, photo.

CALIFORNIAN SEA-LIONS

facing page 182

CHAPTER X

MAMMALS

ALTHOUGH all animal life is believed to trace its first beginnings to the sea, very few of the higher animals—the Mammalia—can be regarded as purely aquatic. With the conquest of land most of the mammals seem to have taken to a chiefly terrestrial existence, those which are usually called maritime principally haunting the sea-shore and taking only to the water in search of food. In this category fall polar bears, sea otters, seals, sea-lions, walruses, etc.

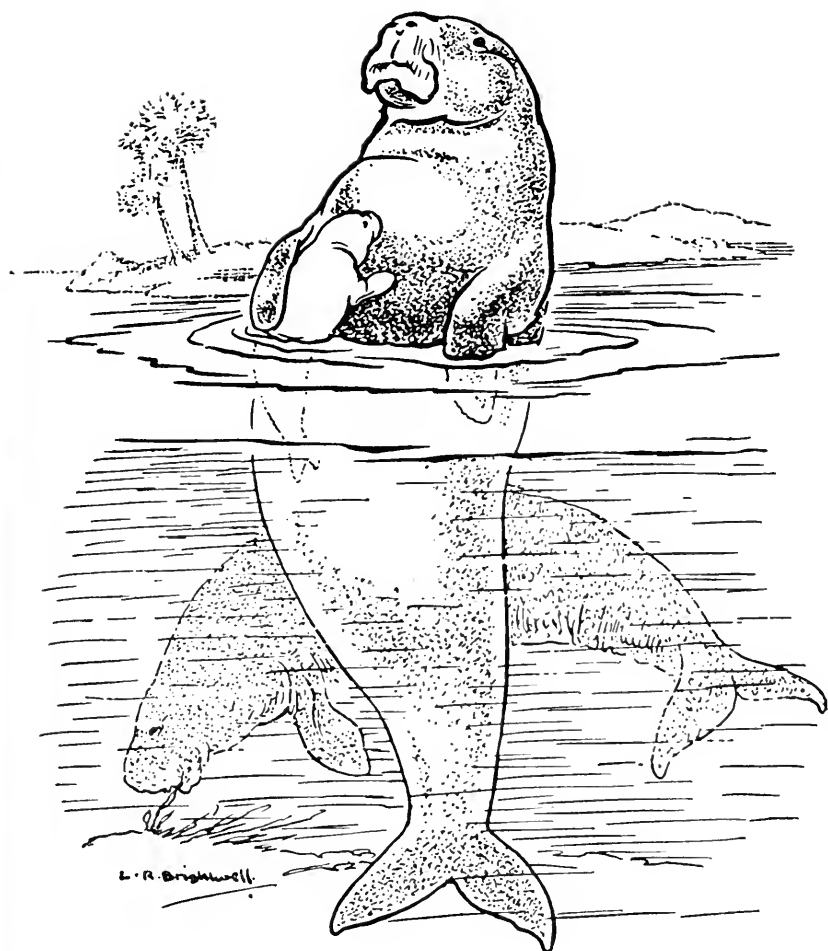
The Whales and Manatees have alone found their sole sustenance afloat, and it is now generally accepted that the Whales are descended from land animals which took to an aquatic life in order to escape predaceous foes on shore. The more primitive Whales certainly have more in common with terrestrial forms than have any of the Whales we know to-day. If indeed the Whale sought safety in the waters it must be admitted that their recent history presents a tragic example of “out of the frying-pan and into the fire.” Modern whaling methods, as will be described later, are fast ushering the world’s largest mammals into the ranks of the extinct, man having devised means of slaughter far transcending the worst efforts of any natural foe.

The only other purely aquatic mammals—the Dugongs and Manatees or Sirens—seem to be on their way towards sharing the Whale's fate, since they are comparatively defenceless and have from early times been hunted for their flesh. In systematic zoology these strange mammals are placed before the more highly specialised Whales since in some respects they show kinship with the hooved animals, notably the elephants, unlikely as any such relationship may appear to the casual observer.

The Manatees and Dugongs (order *Sirenia*) are confined to tropic waters, both salt and estuarine, on both sides of the Atlantic. As the scientific name implies, the mammals suggest by their appearance the classic sirens and mermaids of legend, and it is possible that such mythical beings had their origin in the primitive man's first sight of a Manatee standing waist high out of the water with its single young being suckled at its well-developed breast.

In general appearance Manatees and Dugongs bear some superficial resemblance to Whales. They have the fore limbs converted into flippers and have no hind limbs, but the coarse rough skin is usually sparsely haired and the relatively small head has the upper lip split, the two halves working like a pair of blunt and clumsy claspers, by means of which seaweed is torn from the sea-bed and then tucked into the animal's mouth.

Internally these creatures show unmistakable affinities with the elephants both in the skull and in the pelvic bones, the latter being almost non-existent in the Whale. As with the elephant the young are fed at the breast, and the study of fossil species justifies the conclusion that both originated from common ancestors whose progeny



Dugongs

took opposite roads, the one to browse in the jungle, the other on the sea or river-bed.

The few existing members of the order vary much in

size. The Manatee of the Amazon reaches about 8 ft. in length, whilst the Asiatic and Australasian Dugong more than doubles this measurement, which was much excelled by Steller's Sea Cow, a creature hunted to extinction within recent historic times. The latter animal was discovered in the Bering Islands in 1741, and from then onwards hunted so relentlessly that by 1768 not a single specimen remained. Apparently it had become isolated in the Bering Island group, where, immune to natural foes, it grew to a huge size and lost first its elephantine tusk—preserved in the living Dugong—and finally the remnant of its teeth.

Dugongs differ from Manatees as regards the structure of the skull, in the nostrils being situated on the upper surface of the muzzle, and not at the apex, in the tail being crescentic in shape and not rounded, and in the absence of nails on the flippers.

To-day the remaining Manatees and Dugongs are accorded a certain degree of protection, and on rare occasions are exhibited in zoological gardens. They appear to be the last of a vanishing race, for in the not so remote past they are known to have enjoyed an almost world-wide distribution, fossil remains having been found even in our own country.

Though the precise origin of the Whale is obscure, there is evidence that these animals are of much more ancient lineage than the Manatees and their adaptations to an aquatic life are therefore the more complete. No other marine animals are so cosmopolitan or have taken such full advantage of the vast areas and food supplies at their disposal. As a result the Whales are the largest

animals of the world. The Blue Rorqual (*Balaenoptera sibbaldi*), which reaches a length of over 80 ft., is the largest living creature—recent or extinct.

Before reviewing the principal Whales in order, a glance at their general structure may be advisable. Even to-day many educated persons find it difficult to accept the Whales as mammals, since the wholly aquatic life has led them to adopt a fish-like form that is best suited to rapid transit in water.

The average Whale's skeleton presents many unique features. Though ponderous and heavy it is relatively buoyant, being honeycombed with cells filled with oil. The flippers, stripped of their flesh, are revealed as hands, but the digits have an abnormal number of bones, rendering them very flexible. When an otter or seal takes to the water it will be seen that the hind limbs are held close together in order to obviate resistance. The Whale, abandoning this principle altogether, has practically dispensed with them, only the vestigial thigh bones remaining buried deep within the abdominal muscles.

The skull is of unique shape and usually of immense size, especially in the toothless whale-bone Whales, who require enormous mouths with which to engulf the vast quantities of small creatures on which they subsist. Whales habitually spend considerable periods submerged, and since the top of the head cuts the water first upon rising, the nostrils are situated far up on the head resting just in front of the eyes. In some species the external nasal openings are paired, in others they are united. The bones which go to make the bony tube of the typical mammalian ear are in Whales modified to form a huge semi-globular

box, which in some species is as big as a football. The neck bones are largely fused together, giving great strength but little flexibility.

Without entering into the complexities of its internal anatomy, it may be mentioned that Whales have enormously developed lungs, a very necessary provision, since emergency may sometimes render it desirable for the animal to submerge for an hour at a time. The brain is large and richly convoluted.

The completely aquatic life has rendered hair superfluous, though the few scattered hairs often found on the lips of infant Whales point to an undoubted ancestry of less wholly aquatic origin.

The entire animal is swathed in blubber, or fat, which not only keeps it warm but adds buoyancy. The broad horizontal tail is often wholly composed of this, whilst the forepart of the head may carry a mass of blubber many feet thick which acts as an effective "cut water"—a device copied in the "whale-back" bows of lifeboats and deep-sea trawlers.

The so-called "spouting" of Whales is merely the result of sudden condensation of hot breath in cold air, which appears as a jet of steam; a little surface water may occasionally become intermingled.

Despite the vast numbers of Whales slaughtered annually for their oil, much of the life history of these animals remains a profound mystery. Their vast size makes it almost impossible to keep any in confinement, whilst the wide areas at their disposal and their ability to dive to immense depths makes it equally difficult to follow their movements with any certainty.

Of late years the civilised nations engaged in Whale-hunting have collaborated to make some kind of investigations into Whale movements and economy. The migrations of Whales are largely traced by means of small silver harpoons inscribed with a duly indexed check-number, and these harmless weapons are shot into the animal's blubber, so that when at last killed or washed ashore some idea of its travels may be arrived at through their "passports."

Contrary to the general rule that the larger the animal the more slowly does its progeny develop, Whales would appear to be sexually mature at the very early age of $2\frac{1}{2}$ years. The young are suckled in typical mammalian fashion, and it has been ascertained that the single progeny may be relatively huge, that of an 80 ft. Blue Whale being over 20 ft. at birth. In view of their early maturity it is unlikely that Whales live to a great age.

Whilst a number of species of Whales are evidently confined to certain areas, a large percentage are more or less cosmopolitan, touring the seas according to the dictates of prevailing currents, and the distribution of their food supply. It thus happens that Whales often make very unexpected appearances and our own shores have more than once seen the arrival—in bulk—of various kinds that had previously been recorded as more or less restricted to far distant areas. As an example, the False Killer (*Pseudorca*) had up to the year 1909 been known chiefly from chance examples found in such widely separated seas as those of Denmark and Tasmania. Yet in 1929, 120 of these Whales were stranded in Dornoch Firth, Ross-shire, none being seen again until a score of

individuals ran ashore near Swansea in the summer of 1934.

Whales are divided into two main divisions—the Whale-boned Whales and the Toothed Whales, the latter including the majority of species.

The Whale-bone Whales have no functional teeth and the roof of the mouth is developed into thousands of narrow horny plates, which depend vertically like a vast curtain and act as a sieve which strains off the sea-water, leaving behind the innumerable small animals which serve as food. In the Antarctic species this food consists mainly of shrimps, in the Arctic of sea butterflies or *Pteropods*.

The Whale-bone Whales having been valued both for the whale-bone and their fat have suffered most at the hands of whalers. The Whale-bone Whales, and indeed every other profitable species, will probably one day be extinct as the result of mass slaughter, belated protective measures notwithstanding. The mere figures of some recent "bags" are sufficiently impressive. In the Arctic Seas alone 5,204 Whales of various kinds were killed during 1926-1927, as against 3,516 in 1909-1910. Similar destruction goes on annually in the Atlantic, Pacific and the seas surrounding Japan.

Whaling to-day is totally unlike the hazardous but comparatively leisurely methods one reads in "Moby Dick" or the "Cruise of the Cachalot." The modern whaler is literally a floating factory. Whales are shot with harpoons fired from a cannon, the projectile in its turn exploding within the quarry. The Whale is then inflated to prevent it sinking and the carcass hauled on board. The blubber is removed with immense sickle-shaped knives, mounted

on poles, and boiled down for oil on the spot, whilst the larger bones are cut up with steam-driven saws and likewise boiled for the oil contained in them. Most of the whale-bone—now a drug on the market—is thrown overboard. When it is realised that female (cow) Whales suffer equally with adult bulls the Whale's doom seems indeed inevitable.

The Right or Ballan Whales (*Balaena*) have disproportionately large heads but seldom exceed 50 feet in length. They hail chiefly from the polar seas and are of all the Whales the most easily approached and killed. Together with other Whales they also suffer much persecution from the Killer Whale or Grampus.

The Rorquals (*Balaenoptera*) are not unlike the Right Whales, but have a short back fin and a throat capable of much expansion so that a whole shoal of small fish, etc., can be engulfed at a mouthful. Four species of Rorquals inhabit our seas, the Blue Rorqual, as before mentioned, being the largest living creature living or extinct. It may attain a length of over 80 feet.

The Hump-back Whale (*Megaptera*) also recorded from our waters, is at once distinguished by the immense size of its flippers and its sportive habits. At the mating season this 50 ft. monster indulges in uncouth gambols often leaping high out of the water.

The great order of Toothed Whales comprises a large number of species, many of small size, and distributed throughout every sea, many even ascending far up rivers and invading inland lochs.

The giant is the Sperm Whale or Cachalot (*Physeter macrocephalus*), which provides the valuable ambergris and the clear oil known as "spermaceti," a fluid which is

maintained at the body temperature of the animal and fills special cavities in the head. Its use to the Whale is unknown, but it is prized in commerce for the manufacture of candles and ointment. It solidifies into a white crystalline substance on exposure to the air.

The Cachalot, one of the most ferocious of Whales, often attacking the smaller whaling crafts, is distinguished by its huge square-ended head and in having teeth in the lower jaw only. It is a sociable animal travelling in large herds. It lives chiefly on giant cuttlefish, but seals and even rock lobsters also figure in its diet. Though an inhabitant of warmer seas it may wander in summer as far north as Iceland.

No account of the Sperm Whale could be complete without some reference to ambergris, a fatty compound secreted in the intestinal track of Sperm Whales when in poor condition, and analogous to the gall stones of higher animals. It has been well named "floating gold," for its price is all but fabulous and a world of romance attaches to the substance.

The name "grey amber" was coined by French merchants to distinguish it from true amber, though until comparatively recent times both products were regarded as being of vegetable origin. Whereas to-day the substance is used merely as an essential in the manufacture of perfumes, its natural aroma strengthening the original "bouquet" of the blossoms, it was formerly put to many other purposes. In the *Pharmacopoeia Londonensis*, 1691, it is described as "An excellent corroborative, strengthens heart and brain, revives and recreates spirits natural, vital and family."

The Malays and Chinese still use ambergris for suffusing wines, but in the West its olfactory virtues alone dictate the price, numerous grades being recognised, the highest commanding about £5 per ounce. Dealing in this precious product must be a gamble since in 1922 only 44 lbs. was brought into the American market. This amount realised 11,000 dollars. Scores of Whales are annually killed and searched without yielding a single grain of "floating gold."

Biologically ambergris is of interest since it consists chiefly of the horny beaks of cuttlefish on which the Sperm Whale largely feeds. Though much is known of its chemical composition and properties, it is graded by the expert much as a connoisseur grades wine—by general appearance, bouquet, etc., rather than by any rigid scientific standard.

The Dolphins and Porpoises range in size from the 7 ft. long Common Dolphin (*Delphinus delphis*) to the 30 ft. long Grampus or Killer (*Orca gladiator*). The Porpoises are distinguished by their comparatively blunt heads, whilst Dolphins usually have a distinct beak. All travel in herds or schools.

To the Common Porpoise (*Phocaena communis*) we owe much of our knowledge of Whale habits in general, since Porpoises often entangle themselves in herring nets, and such specimens occasionally find their way to large public aquaria.

The last specimen exhibited in the Brighton Aquarium lived there for four months, travelling many thousands of miles up and down its tank during that period. It became remarkably tame, feeding from the hand only two days

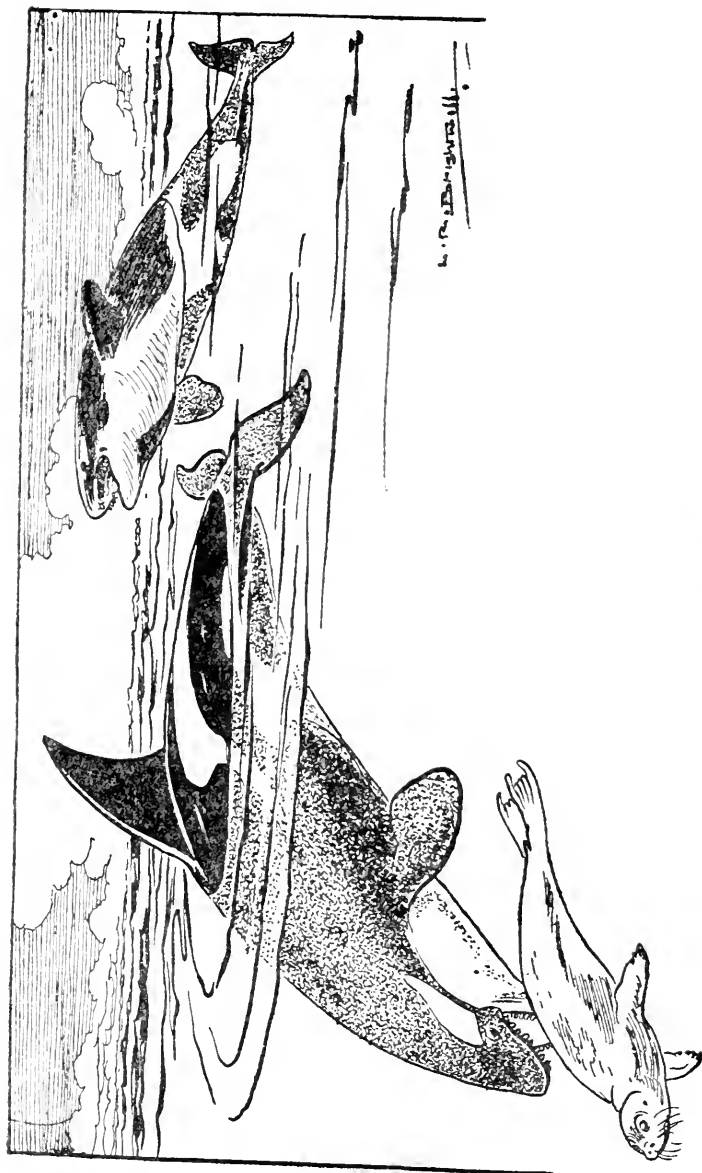
after its capture. Though prone to basking when the sun shone into its tank, it appeared never to sleep, or, if it slept, never to entirely cease its steady forward movement. Its average progress was at the rate of some six miles an hour.

Porpoises and Dolphins feed almost exclusively on fish, but the Killer Whale is virtually omnivorous as regards animal foods. In one specimen the remains of fourteen small Porpoises and several seals were found, whilst penguins figure largely in its menu when it visits antarctic waters.

It travels in vast shoals, chiefly frequenting warm seas, though stragglers reach our northern shores and one has been known to ascend as far up the Thames as Chiswick.

The Grampus or Killer has well been dubbed the "Wolf of the Seas." Although its striking jazz pattern of black and white serves to make it largely invisible when travelling at high speed in a boil of foam, its immense high backfin makes it a conspicuous object when swimming at the surface. Though nothing comes amiss to it, it lives largely on the larger Whales, hunting them in packs and literally eating them alive, when not infrequently it uses its wedge-shaped head to force open the victim's mouth, when it tears out the tongue—a titbit which it is particularly fond of.

Like most Porpoises it shows a high degree of intelligence and courage. Frequently it will chase penguins until they seek refuge on an ice floe. The Killer will then dive beneath and deliberately seeks to bump them off into the sea, sometimes splitting floes several feet thick with its powerful



Killer Whale

arch back. Like all Toothed Whales—save the Cachalot—it has numerous teeth in each jaw.

Whilst most Whales tend to be of a dark coloration, the White Whale or Beluga (*Delphinapterus leucas*) is of a uniform glistening white. It frequents all the northern seas, sometimes entering home waters, and is much in demand, its skin providing commercial “porpoise hide,” that of the true Porpoises being quite valueless.

The Narwhal or Sea Unicorn (*Monodon monoceros*), though nearly related to the White Whale, is unique in its extraordinary dentition. Apart from a few rudimentary teeth situated normally in the jaws, its dental outfit would seem to be concentrated in a pair of immense upper tusks standing out horizontally from the head like the rostrum of a swordfish. In the female these remain hidden in the flesh and fat of the upper jaw, but in the male one—usually the one on the left—is developed into a long spiral several feet in length. A big adult male may measure 15 ft. in length, with a tusk nearly 8 ft. long.

The Narwhal is an inhabitant of the arctic seas, where it feeds wholly upon fish—cod, flatfish and salmon. It is largely hunted by the Eskimos, who eat the skin raw, use the blubber for fuel, and feed the flesh to their dogs. Narwhals are of a greyish white mottled colour, which serves almost as a cloak of invisibility in the choppy waters of their arctic home.

In conclusion it may be said that though the full story of the Whale's ancestry has yet to be told, there is little doubt that the race can trace its beginning from certain terrestrial or semi-aquatic mammals that flourished in the remote past. Primitive Whales have serrated teeth not

unlike those of some carnivores living to-day. In addition their neck vertebræ are free instead of being fused together, whilst the ribs and articulation of the fore limb are much more suggestive of terrestrial carnivores than the purely aquatic whales still living.

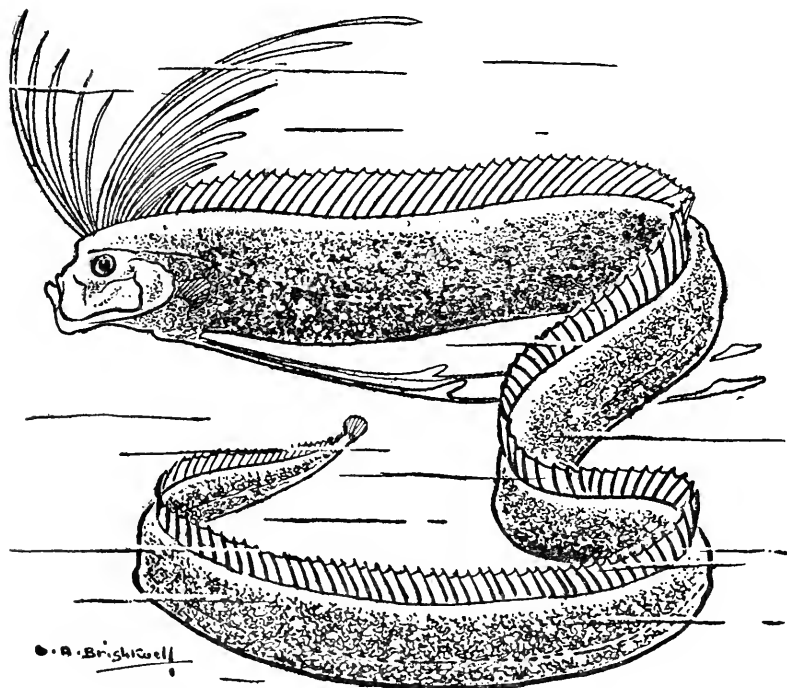
Oturi Forests is a discovery of less than 40 years, and the sea with its vast areas still uncharted may well harbour some monsters hitherto unknown. One must at the same time take into account the deceptive distances of the open sea and the baffling tricks played by light, wind, cloud and waves upon the human sight. Many a normal phenomena such as a flock of guillemots in single file, the long arm of a big squid, a shoal of porpoises, wreckage, and especially ribbon fish, have been often mistaken for giant sea snakes.

Accounts of alleged sea serpents are abundant in the literature of all nations and they show no signs of diminishing with the passage of time. Appearances of the sea serpent were collected by a Netherlands enthusiast, who tabulated some 250 cases between the years 1520 and 1890. None of these can be called convincing, though it would take a very *blasé* film fan to say the mildest was not startling.

One of the more recent instances was that of the monster seen from the deck of H.M.S. *Dedalus*. This creature had a lizard-like head with immense jaws full of long and rugged teeth. Not many years later so reputable a journal as "The Zoologist" published an account of a sea serpent which attacked a party of fishermen in Bally Cotton Bay. On being shot at it disappeared after disgorging a shoal of fish, which being handled gave a series of terrific electric shocks. In the same year another, or perhaps the same monster, was seen at death grips with a sperm whale.

One of the most convincing sea serpent stories—convincing because of the public position held by the witnesses—was that connected with the Earl of Crawford's yacht

when coasting off Brazil. On this occasion the late Mr. E. G. B. Meade-Waldo, a member of the Council of the London Zoological Society, and the late Mr. M. J. Nichol, one-time assistant-director of the



Ribbon Fish—often mistaken for sea-serpent

Cairo Zoo, actually beheld a turtle-shaped head rear itself above the waves on a neck fully 6 ft. long. At the base of the neck appeared to be a fin, but the serpent—like all of its class—exhibited the characteristic coyness, and after following the ship for a few minutes at about eight

knots per hour very disappointingly dived and was seen no more.

Much more impressive was the sea serpent observed by Oleus Magnus, Archbishop of Upsala, in Sweden, in the sixteenth century. According to this dignitary the monster often enjoyed a snack by helping itself to live sheep browsing at the cliff edge, and when seriously pressed by hunger did not hesitate to engulf a three-masted schooner with captain, crew and deck fittings complete. To-day when every schoolboy makes some claim to a passing acquaintance with the theory of evolution and a general knowledge of geological processes, such stories seem beyond the bounds of serious consideration. It must be borne in mind, however, that the worthy prelate of Upsala represented the intellectual flower of a period when the commonplaces of modern natural history were undreamed of even by the most erudite. In the sixteenth century, for example, the more progressive of the intelligentsia were at war amongst themselves as to the true origin of fossils of any description. The more advanced thinkers maintained that fossils developed from moist sea-bearing vapours that rose from the sea and penetrated the earth. To-day we are still hot upon the scent of a monster that has exercised man's brains since earliest times. In some respects we are in even worse case than that of the good Archbishop of Upsala, for he was apparently able to give a graphic description of the sea serpent to an engraver of the period, who immortalised the whole stirring episode for the edification of future generations. That such a monster should have existed in the sixteenth century must then have seemed reasonable enough, for Oleus Magnus told

his world of many other sea animals scarcely less impressive. Between the Orkneys and Hebrides, for example, there was believed to dwell a race of lobsters so large that they habitually waylaid and devoured fishermen. As late as 1830 Mr. L. A. G. Bosc, in his "Natural History of the Crustacea," gave a description of these lobsters and their habits. He also set on record that off the coasts of Tropical America there dwelt a race of man-eating crabs.

It is conceivable that the sea serpent is yet another instance of the nandi bear. This animal, though of terrestrial origin, is very germane to the matter under discussion since it illustrates to perfection how wild stories may originate and the readiness with which they are generally accepted.

From 1920 until 1930 the press both at home and abroad published from time to time reports of the mysterious and sinister mammal reputed to live in the dark and gloomy rain forests of Kenya Colony, an area which is much less difficult of exploitation than the deep sea. The nandi bear apparently blended man and hyæna. It could walk erect, but was chiefly addicted to lying out upon some overhanging branch and seizing women and children as they passed beneath. In August, 1926, there came from the Game Warden of Nairobi a report of the nandi bear killing a child and decamping, but not before he had left its spoor clearly visible, a print of one of these foot-marks being taken by the Warden and forwarded to the "Field," in which journal it was published. Reports became more and more insistent and conflicting until in 1930 the Natural History Museum authorities organised a thorough investigation. Every registered game warden or district

commissioner in the vicinity of the bear's habitat at once was circularised, and at length concrete evidence in the form of skins and skulls was forwarded to the Museum for identification. In every instance the remains were those of a leopard or hyæna, the skin of the one being forwarded with the skull of the other and *vice versa*, the two being alleged to have belonged to the same animal. Foot-prints, however, first aroused the suspicion of the authorities since it shows six distinct digits, a feature quite unknown in any mammal—recent or extinct. Upon close examination the foot-print resolved itself into the prints of two separate animals, one having implanted its fore paw in the spoor of another.

This chapter would be incomplete without a short resumé of the facts connected with the famous Monster of Loch Ness, an animal as yet unidentified, but which held the attention of half the world for more than a year and is still, according to some authorities, at large.

The case is of the first importance since it touches the very root of all such appearances, the human factor. The matter has already been made the subject of two complete and weighty volumes, one by a German Professor, the other by Lieut.-Commander R. T. Gould.

The loch itself lies in the heart of Inverness-shire, and is the largest body of fresh water in the British Isles. Some thirty years ago the famous oceanographer, Sir John Murray, subjected it to a detailed survey. He found it to have an average depth of 500 feet, and a maximum of 751 feet. It is $22\frac{1}{2}$ miles long, with three approaches to the sea, and whilst these are all under continuous observation there seems some possibility of a large creature

gaining admittance unobserved. For centuries the loch, with its wild and lonely surroundings, has been subject to grim legend and eerie rumour. Amongst its phantom fauna may be cited the kelpie or water horse, an evil bovine-equine hybrid, said to have its home in one of the loch's many subterranean channels. Of late years a certain boating fatality revived the old legend that the loch never gave up its dead. In fact the stage was perfectly set for the grotesque and diverting drama which began in June, 1933, and still enjoys periodic, if somewhat half-hearted, revivals.

In October of the same year the storm burst. Numerous people saw the creature and gave the most conflicting accounts of its appearance. It was of immense size, had arms, a mane, and eyes like the headlights of a powerful car. All Britain might be said to have taken sides upon the issue. The pro-monster party passionately supported their pet, whilst the sceptics unkindly explained it away as a porpoise, seals, or a floating tree trunk, and even hinted that it was the invention of a certain daily journal which gave it considerable publicity.

In the spring of the following year enthusiasm rose to fever heat. A well-known big-game hunter went in search of it and was made the victim of an uproarious hoax, being led to discover foot-prints, later diagnosed as having been made by a hippopotamus-foot door-stopper. One courageous man actually broadcast his "eye witness" account of the monster crossing a public highway with a dead sheep in its mouth. A Harley Street specialist photographed it, and the Williamson Brothers, pioneers of undersea cinematography, journeyed specially from

America with a view to taking "close ups." The animal, still unidentified, was made the subject of endless jests and leg-pulls, whilst inns and hostelries within any reasonable distance of the loch enjoyed an unprecedented boom. A shortage of salmon in the loch was of course attributed to it.

Considerable jealousy was aroused in every monster-haunted district, and some attempt was made to revive interest in the ogo pogo of the Canadian lakes. An American zoo offered £5,000 for the Loch Ness animal—alive.

When the general enthusiasm was at its height, Sir Arthur Keith published an article pregnant with clear thinking and incurable sanity that one cannot forbear a few selected quotations. Sir Arthur Keith observed: "The scepticism of the professional zoologist is due to the nature of the evidence that is being placed before him. In the case of the okapi, Sir Harry Johnson could at least show a skin, but those who have convinced the Secretary of Scotland and the Chief Constable of Inverness-shire of the existence of the monster have not seen a scale or hair of its skin, or a nail of a toe to produce as evidence. To keep such a big body supplied with food a monster must work long hours, and we should find numerous traces of his repast. He must have a father or mother somewhere living or dead; he should have sisters and brothers, cousins, and uncles and aunts." Sir Arthur finally reminded his readers of the Russian soldiers said to have passed through England in the first year of the War, and of the angels seen at Mons. He summed up thus: "I spent my boyhood on the banks of a river that

flows into the Moray Firth. I knew men and women who had seen kelpies at a certain dark pool, not once but many times. Like the Loch Ness monster kelpies could be seen but not touched. I did not believe in them then, and nothing has happened since to alter my mind. I have come to the conclusion that the existence or non-existence of the Loch Ness monster is not a problem for zoologists but for psychologists."

There in a few sentences is the whole crux of the matter. The reputable scientist neither dismisses nor accepts a report without weighing the facts, but facts and concrete evidence he may very pardonably require before accepting the evidence of the untrained observer.

INDEX

Acorn Barnacle, 35
 Acipenser, 137
 Adamsia, 32
 Alcyonium, 26
 Alpheus, 44
 Ambergris, 192
 Amblyrhincus, 178
 Amphineura, 85
 Amphioxus, 118
 Amphipods, 38
 Amphiprion, 162
 Anarhicas, 138
 Anemonia, 30
 Anemonies, 29
 Angler Fishes, 127, 133, 138, 170
 Anguilla, 158
 Anomia, 97
 Anomura, 44
 Antedon, 63
 Antennariidae, 122
 Aplacophora, 86
 Aplysia, 93
 Apogonichthys, 161
 Aporrhais, 89
 Arca, 97
 Archiututhis, 110
 Arc Shells, 97
 Arctus, 42
 Arenicola, 75
 Argonaut, 112
 Aristotle's Lantern, 68
 Arrow Crab, 48
 Ascidians, 114
 Ascidiella, 117
 Asterias, 66
 Aurelia, 23

Balaenoptera, 187, 191
 Balanoglossus, 71
 Ballan Whales, 191
 Barrier Reefs, 29
 Bashful Crab, 48
 Basket Stars, 67
 Basking Shark, 142
 Bat Fishes, 133
 Bath Sponge, 16
 Bêche de Mer, 62
 Beluga, 196
 Birgus, 46
 Blennius, 166
 Blind Goby, 155
 Blue Rorqual, 187
 Blue Tiger Shark, 142
 Boat Shell, 93
 Bopyrus, 38
 Boring Sponge, 16
 Botryllus, 117
 Brachypods, 71
 Brachyura, 47
 Brechites, 103
 Bristle Worms, 75
 Brittle Stars, 67
 Bubble Shells, 93
 Buccinium, 90
 Bugles, 82
 Butterfish, 165

Cachalot, 192
 Calanus, 35
 Calappa, 48
 Calling Crab, 54

- Carcharias, 142
 Carcharodon, 172
 Cardium, 101
 Caretta, 174
 Carinaria, 89
 Carrier Shells, 89
 Caryophyllia, 28
 Cellaria, 82
 Cephalopods, 103
 Cestus, 26
 Cetorpinus, 142
 Chaetopterus, 80
 Chaunacidae, 122
 Chelonia, 174
 Cheloniidae, 174
 Chiasmodon, 150
 Chitons, 85
 Choliodus, 138
 Chrysaora, 24
 Ciona, 115
 Cirripedia, 35
 Clams, 10
 Cliona, 16
 Cockles, 101
 Coconut Crab, 46
 Cod, 150, 154
 Coelenterates, 19
 Conus, 92
 Copepods, 34
 Coralliophila, 91
 Corals, 26
 Coral Whelk, 91
 Corystes, 51
 Cow Fish, 135
 Cowry Shell, 88
 Crawfish, 42
 Crinoids, 63
 Crocodiles, 177
 Crocodylus, 177
 Crustaceans, 33
 Ctenopores, 24
 Cucumaria, 60
 Cushion Star, 66
 Cuttlefish, 108
 Cyanea, 24
 Cyclopterus, 126, 166
 Dactylopterus, 124
 Dahlia Anemone, 30
 Date Mussels, 98
 Dead Men's Fingers, 26
 Deal Fish, 129
 Decapods, 40
 Delphinus, 193
 Dentalium, 96
 Dermochelys, 171
 Devonshire Cup Coral, 28
 Dibranchia, 106, 107
 Dogfish, 137, 164
 Dog Whelk, 91
 Dolphins, 193
 Dragon Fish, 125, 128
 Dublin Bay Prawn, 42
 Dugongs, 184
 Ear Shells, 87
 Echenius, 130
 Echinocardium, 70
 Echinoderms, 59
 Echinus, 68
 Ecl, 158
 Eriocheir, 54
 Eulamillibranchia, 100
 Eulima, 89
 Eurialidae, 67
 Euryharynx, 150
 Exocoetidae, 123
 False Killer Whale, 189
 Fan Mussels, 101
 Fasciolaria, 91
 Ficulina, 15

Fiddler Crabs, 51
 Fierasfer, 60
 Fig Sponge, 15
 Filibranchia, 97
 Fishes, 120
 — abyssal forms, 152
 — air bladder, 140
 — breeding habits, 163
 — colour changes, 146
 — courtship, 163
 — dentition, 136
 — fins, 120
 — form of, 132
 — hearing power, 139
 — jaws, 136
 — light organs, 152
 — longevity, 139
 — migrations, 156
 — parasitism, 160
 — partnership, 161, 170
 — size of, 140, 146
 — swallowing capacity, 150
 Flask Ascidian, 115
 Flask Sponge, 15
 Flat Lobster, 42
 Flexible Coral, 26
 Floating Crab, 53
 Flustrella, 82
 Flying Fish, 123
 Flying Gurnard, 124
 Foraminifera, 13
 Fountain Shell, 92
 Frog Fishes, 122
 Furrowed Crabs, 50

Gadus, 150, 154, 156
 Gaff-topsail Fishes, 169
 Galathea, 46
 Gastropods, 86
 Gelasimus, 54
 Giant Clam, 102
 Giant Spider Crab, 50

Giant Whip-Ray, 144
 Glass Shells, 89
 Glass Sponge, 16
 Globe Fish, 135
 Glory of the Sea Cone, 92
 Gobies, 125, 166
 Gobioides, 125
 Goose Barnacles, 36
 Gorgonia, 26
 Grampus Whale, 193
 Grapsus, 53
 Green Turtle, 174
 Gribble, 38
 Gurnards, 122

Haddock, 156
 Hag Fishes, 136, 154
 Haliotis, 87
 Hammer-headed Shark, 142
 Haplostolea, 138
 Hawksbill Turtle, 176
 Heart Urchin, 70
 Hedgehog Hydroid, 20
 Henslowi, 51
 Hermit Crabs, 44
 Hermit Crab Worm, 76
 Heterosomata, 133
 Hippocampus, 132, 136, 138, 169
 Holothuria, 60
 Hump-backed Whale, 191
 Hyalinoecia, 77
 Hydras, 181
 Hydroids, 20

Ianthinidae, 88
 Iguana, 176
 Isopods, 38
 Isthiophorus, 130

Jellyfishes, 24
 John Dory, 132, 147



Kecled Tube Worm, 80
 Killer Whale, 193
 King Crab, 55

Labridae, 138, 165
 Lamellibranchia, 96
 Lampreys, 136, 154
 Lamp Shells, 72
 Lancelet, 118
 Land Crabs, 51
 Langouste, 42
 Latrunchus, 140
 Leaf Worms, 76
 Leathery Turtle, 171
 Lepas, 36
 Lepralia, 82
 Leptoclinum, 117
 Leptoplane, 74
 Leptopodia, 48
 Limnoria, 38
 Limpet, 86
 Limulus, 55
 Lineus, 74
 Ling, 164
 Lithodomus, 98
 Littorina, 88
 Lobsters, 41
 Loch Ness Monster, 204
 Loggerhead Turtle, 174
 Lophiidae, 127
 Lophius, 127, 138
 Lug Worm, 75
 Luidia, 66

Macropodia, 48
 Maia, 50
 Mammals, 183
 Manatee, 184
 Mantis Shrimp, 39
 Masked Crabs, 51

Megaptera, 191
 Membranipora, 82
 Mitten Crab, 54
 Mola, 136
 Molluscs, 84
 Molva, 162
 Monodon, 196
 Moschites, 112
 Mudskipper, 120
 Muggiaca, 21
 Mullus, 154
 Murex, 91
 Mussels, 97
 Myxine, 136, 154

Nassa, 91
 Narwhal, 196
 Nautilus, 105
 Nephrops, 42
 Nereis, 75
 Noctiluca, 14
 Nucula, 97
 Nudibranchs, 95
 Nut Shell, 97

Oar Fish, 129, 146
 Octopus, 110
 Oikopleura, 117
 Opelet Anemone, 30
 Ophiocoma, 67
 Ophiura, 66
 Ormers, 87
 Ostracionidae, 135
 Otoliths, 139
 Ovula, 88
 Oyster, 100

Palinurus, 42
 Palolo Worm, 79
 Parasitic Anemone, 30
 Parchment Tube Worms, 80

Patella, 86
 Peacock Worm, 77
 Pea Crabs, 54, 98
 Pearl Oysters, 99
 Pearls, 99
 Pectens, 100
 Pelican's Foot Shell, 89
 Periophthalmus, 120
 Periwinkles, 88
 Petromyzon, 136, 154
 Phocaena, 193
 Pholas, 102
 Pholis, 164
 Photoblephron, 153
 Phyllodoce, 76
 Physeter, 191
 Piddocks, 102
 Pinna, 101
 Pinnotheres, 54
 Pipefish, 138, 169
 Pirana, 136
 Pisa, 49
 Planes, 53
 Plumose Anemone, 31
 Poached Egg Shell, 88
 Podophthalmus, 51
 Polychaeta, 75
 Polyps, 19
 Polypus, 110
 Polyzoa, 81
 Pomatocerus, 80
 Porania, 66
 Porose Crocodile, 177
 Porpoises, 193
 Portuguese Man-of-War, 21
 Portunus, 51
 Precious Coral, 28
 Prickly Sea-Mat, 82
 Pristidae, 143
 Protobranchia, 97
 Protozoa, 13
 Pseudorca, 189
 Pterois, 125
 Psychogonidae, 57

Pygidiidae, 161

 Quill Worm, 77

 Radiolaria, 13
 Rag Worm, 75
 Raia, 126, 132, 137
 Ray, 126, 132, 137, 164
 Razor Shell, 102
 Red Mullet, 154
 Reef-building Corals, 26, 28
 Regalecus, 146
 Remoras, 130, 162
 Reptiles, 171
 Rhineodon, 140
 Rhizostoma, 24
 Ribbon Fish, 146
 Ribbon Worms, 74
 Right Whales, 191
 Rock Borers, 102
 Rock Salmon, 138
 Rorquals, 191
 Ross, 82
 Rosy Feather Star, 63

 Sabella, 77
 Sacculina, 36
 Sack Barnacle, 36
 Sacred Chank Shell, 90
 Saddle Oysters, 97
 Sagartia, 30
 Sail Fish, 130
 Sallee Rover, 21
 Salmo, 157
 Salmon, 157
 Salpa, 117
 Sapphirine Gurnard, 123
 Sand Crabs, 48
 Sand Mason Worm, 77
 Sand Stars, 66
 Sand Urchin, 70

Saw Fishes, 143
 Saxicava, 102
 Scallops, 100
 Scaphander, 94
 Scaphopoda, 96
 Scyliorhinus, 137
 Scyphozoa, 23
 Sea Blubber, 24
 Sea Cucumbers, 60
 Sea Egg, 68
 Sea Fan, 26
 Sea Gooseberry, 24
 Sea Hare, 93
 Sea Horse, 132, 136, 138, 169
 Sea Lilies, 65
 Sea Monsters, 198
 Sea Moths, 94
 Sea Mouse, 76
 Sea "Serpents," 200
 Sea Slater, 38
 Sea Slugs, 95
 Sea Snakes, 180
 Sea Spiders, 57
 Sea Unicorn, 196
 Sea Urchins, 67
 Sepia, 108
 Septibranchia, 103
 Sharks, 126, 140
 Shark-suckers, 130, 162
 Shelled Urchins, 70
 Ship Worms, 102
 Sirenia, 184
 Skates, 132
 Snap Lobsters, 42
 Solaster, 66
 Solen, 102
 Sperm Whale, 191
 Sphargidae, 172
 Sphyrna, 142
 Spider Crabs, 48
 Spinachia, 165
 Spirula, 107
 Spondylus, 99
 Sponges, 14

Squat Lobster, 46
 Squids, 108
 Squilla, 39
 Starfishes, 64
 Stickleback, 165
 Stomalopoda, 39
 Strombus, 89, 92
 Sturgeon, 137
 Sun Fish, 136
 Sun Star, 66
 Swimming Crabs, 50
 Sword Fishes, 143
 Sycon, 15
 Syphonophores, 21
 Sygnathus, 138, 169

 Tarpon, 144
 Telia, 30
 Terebella, 77
 Teredo, 102
 Tetrabranchia, 105
 Tetraodon, 135
 Thorny Oysters, 99
 Thylogobius, 155
 Thynnus, 144, 156
 Toad Fishes, 122
 Top Shells, 87
 Toothed Whales, 191
 Tooth Shells, 95
 Trachinus, 128
 Tridacnia, 102
 Trigger Fishes, 129, 150
 Trigla, 122, 125
 Trinia, 88
 Triton, 95
 Tritonia, 95
 Tubicinella, 36
 Tunicates, 114
 Tunny, 144, 156
 Turbellaria, 74

 Umbraculum, 93

Umbrella Snails, 94

Velvet Cloak Anemone, 32

Venus's Girdle, 26

Violet Snails, 88

Watering-pot Shell, 103

Weevers, 128

Whalebone Whales, 190

Whales, 186

Whale Shark, 140

Whelks, 90

Whip Rays, 144

White Shark, 142

White Whale, 196

Wind Shells, 89

Wolf Blenny, 138

Worms, 73

Wrasses, 138, 165

Xantho, 50

Xidiidae, 145

Zeus, 137, 147

